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ANATOLIAN LUCERNE

F. CHRISTIANSEN-WENIGER and O. TARMAN

Ankara, Turkey.

[Translator: G. M. ROSEVEARE]

THERE are many reasons why Anatolian lucerne should attract the attention of all students of this plant. In the first place, eastern Anatolia forms part of the home region of cultivated lucerne; in the second place, the use of lucerne for pasture is a very old practice in Anatolia, and probably also its cultivation as fodder for horses. Further, the natural conditions under which it is grown are extraordinarily varied, so that populations in close proximity to one another are subject to very dissimilar growth factors. And, in addition, lucerne must be regarded as one of those Anatolian crop plants in which a great number and variety of hereditary factors are hidden. Those factors, if developed by breeding, would represent, according to Vavilov (**1**), a value worth millions.

The present article, which is prefaced by a brief outline of the climatic bases governing cultural conditions, deals first with the wild lucerne found in Anatolia and with its cultivation there at the present time, and then with the different forms of cultivated lucerne, with the important local varieties, and with breeding work and seed production.

The country has been divided into regions embracing different conditions for agricultural activity, in accordance with the morphological structure of Anatolia, the natural drainage systems arising therefrom, and the climatic conditions. This division comprises ten great regions, each of which has a number of sub-divisions (cf. A. T. Göymen (**2**)). Table 1 (pp. 66 and 67) gives a review of climatic conditions in the ten regions respectively.

If the data given in the table are compared with those which Könekamp (**3**) gives for an international trial, conducted at eight different centres situated in three widely separated parts of the world, it is seen that the climatic differences in Anatolia are considerably greater than those in Könekamp's trial. In the latter the average annual temperature ranged from 7.3° to 17.2°C., while in Turkey it ranges from 4.6° to 19°C. (cf. Fig. 2). The highest average temperature of the warmest month in Turkey is approximately 31.2°C. It approximates to that of the hottest parts of the earth; the lowest average temperature is −13.1°C. Fig 3 shows that the absolute minima at Antalya are sometimes higher than the mean temperatures of Kars. The

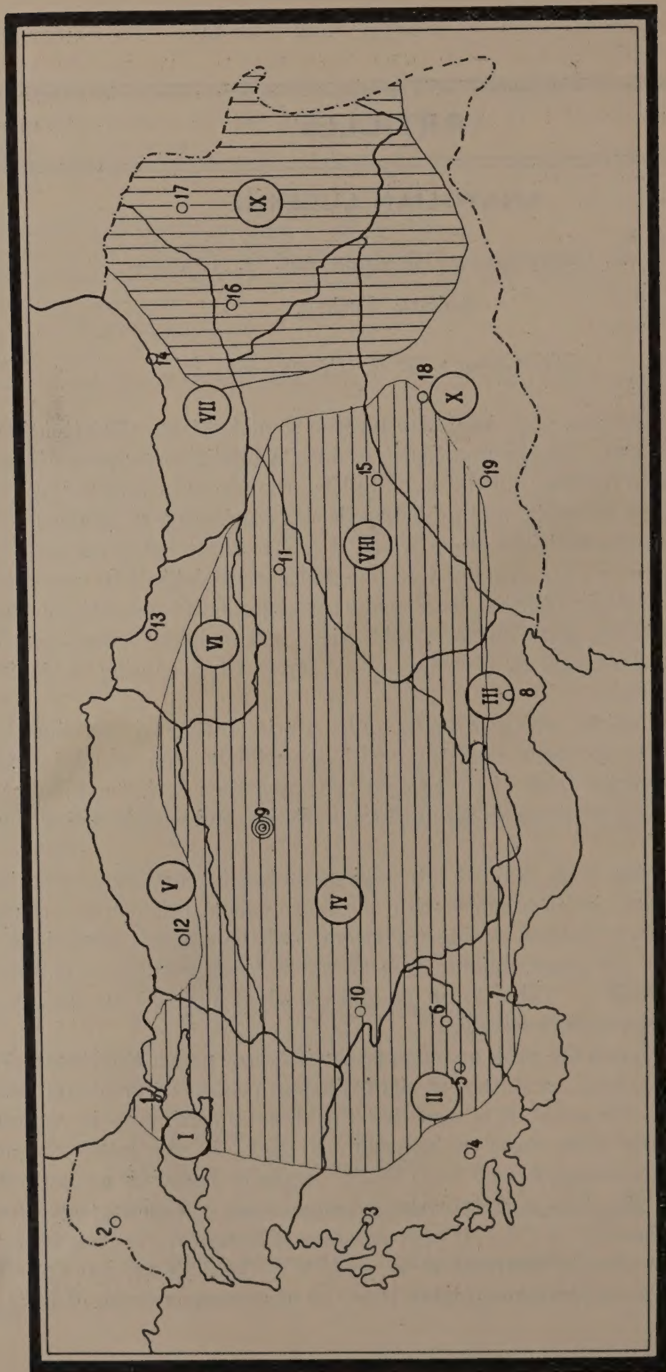

Fig. 1. Map of Turkey. I to X. Agricultural regions.
1 to 19. Places mentioned in Table 1. (pp. 66-7).
[horizontal hatching] Area occupied by the central Anatolian lucerne.
[vertical hatching] Area occupied by the east Anatolian lucerne.

mean figures for precipitation range from 331 to 2,526 mm. The extremes are 176 and 3,555 mm. The number of summer days, that is, days on which the mean temperature in the shade exceeds 25°C., amounts to 199 days in Adana and only 54 in Kars ; the number of days on which frost occurs, on the other hand, ranges in the different regions from 1 to 180. To this it must be added that, on account of the relatively wide-meshed net of observation centres, there is no doubt that the extremes to be found in the country are not yet fully known.

Side by side with regions having a definitely continental climate, there are others with uniform maritime climate. Fig. 4 shows the course of the average temperatures of Rize, Urfa and Kars. The difference between the average temperature of the warmest and the coldest months amounts to 16.2°, 26.3° and 31.4°C. respectively. The absolute annual variation in the places mentioned is 42.2°, 56.4° and 68.5°C.

In summarizing, therefore, it may be said that in Turkey there are found, within a small radius, climatic extremes such as can rarely be found elsewhere in such close proximity to one another. There are in addition, within the different climatic regions, numerous climatic islands (Christiansen-Weniger (**4**)) and local climates.

Soil conditions also are naturally very varied, and it is not necessary here to give detailed information on this subject.

The growth conditions encountered by lucerne in the different regions are therefore extraordinarily dissimilar. In the actual home of lucerne, which on the whole coincides with Agricultural Region No. IX, extreme continental conditions prevail, with summer temperatures amounting to as much as 35°C. and winter extremes as low as -35°C. But lucerne cultivation has been extended as far as the hot subtropical coastal regions, for example, Antalya.

A distinction must be made between the wild lucernes and the cultivated lucerne. Wild lucerne is found in abundance, especially in east Anatolia, where both *sativa* and *falcata* grow wild, and also the intermediate forms of *media*. We found plants of *sativa* with definitely prostrate growth. The stems of these forms hardly stand up at all, but lie close to the ground. A plant of this kind frequently covers an area of 50 to 60 cm. in diameter, and in exceptional cases as much as 1 sq. m. (cf. Fig. 5). Close to these again we found forms which grew perfectly erect. Leaf form also, as well as the ratio of leaf to stem, exhibits great variation.

The wild lucernes of east Anatolia are found not only in the high plains of the region, where they constitute in places a considerable proportion of the wild flora, but they also grow on the mountain sides and ascend to altitudes of far above 2,000 m. For the crop producer it is unusually interesting to know that some wild lucerne forms apparently tolerate concentrations of salt in which other plants die or become stunted. Thus we observed near Van a vigorous stand of wild lucerne, whereas cultivated wheat in this locality is very seriously affected (cf. Christiansen-Weniger (**5**) and Christiansen-Weniger and A. Hadi (**5a**)). This harmonizes with observations made by Busse (**6**) in Turkestan.

East Anatolia, which is considered to form part of the original home of lucerne, confirms the saying of Schwarz and Klinkowski (**7**) : " The area in which lucerne was

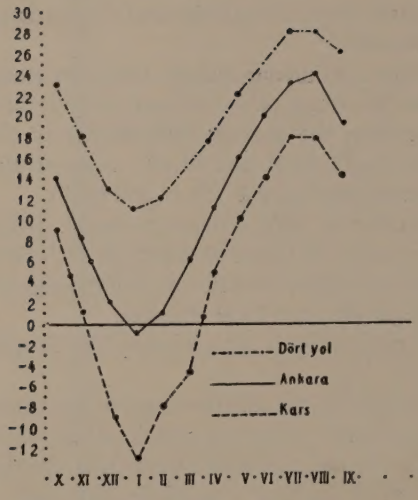

Fig. 2. Monthly average temperatures of Dörtyol (on the south coast near Adana), Ankara and Kars.

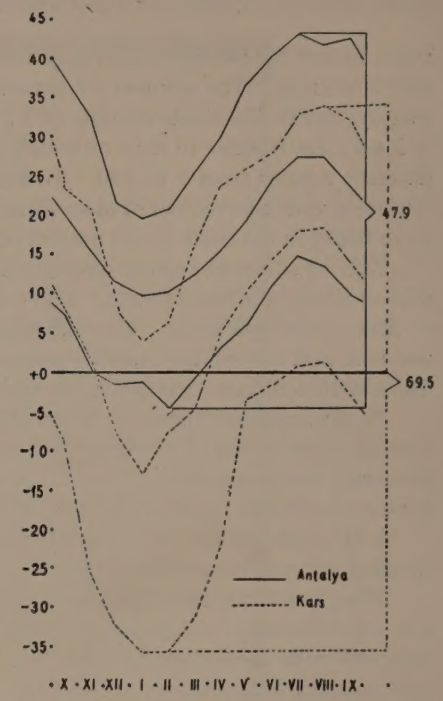

Fig. 3. Monthly average temperatures, maxima and minima of Antalya and Kars.

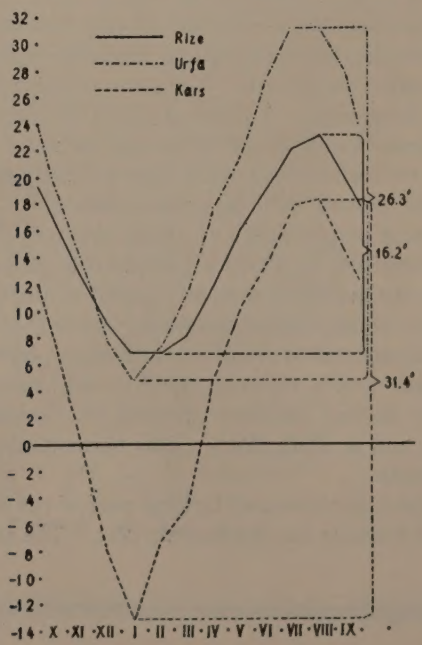

Fig. 4. Monthly average temperatures, and difference between the mean temperature of the warmest and coldest months at Rize, Urfa and Kars; maritime to continental climate.

bred lies in the region where, more than in any other part of the world, the continental climate is most consistently realized."

When we turn now to the cultivation of lucerne in Anatolia, it is found that the old and original regions with widely extended cultivation are, in the east, Erzerum, Erzincan and Van ; and in central Anatolia, Kayseri, Yozgat, Konya, and Isparta. These are regions of definitely continental climate. Only recently has the cultivation of lucerne extended to the coasts, namely, as is shown in the map, to two regions ; (1) in the south, Antalya ; and (2) on the northwest, Bursa. Cultivation here, however, is quite recent. Of Bursa Tarman says (**8**) : " In the province of Bursa there are still to be found the old lucerne growers, who saw the beginning of lucerne cultivation in this region."

We have to distinguish, therefore, two different, original zones of cultivation, one of which is the eastern region. Here lucerne is cultivated in high localities with a definitely severe climate. The most important factor governing growth is, in addition to water, heat. In the districts of Erzerum, Kars and Van only two cuts can be taken, at the most three, even when—as is generally the case—the lucerne is irrigated. Tarman (**8**) proved that the varieties grown here are *sativa* forms with not even an admixture of *media*. As we have shown above, these regions have an extreme continental climate with very cold winters.

In the neighbourhood of Kars the average temperature in January is -13°C. In this region lucerne is subjected to 180 days frost and 80 winter days. The snow covering is frequently unbroken for many months. Nevertheless the lucerne lasts well, and we found that in some cases it was used for as much as fifteen years. The cultivation of *Medicago sativa* in east Anatolia contradicts the commonly held view that this form thrives only in a warm, mild climate. Fischer says, for example (**9**): " The *sativa* lucerne has extremely high warmth requirements and thrives best in the 'vine climate' and mild 'winter cereal' climate."

In central Anatolia, lucerne is still cultivated entirely under irrigation. It can give from four to five cuts here, under good management. In the old cultivation district near Kayseri, lucerne is very persistent. Many farmers report that they have taken over the fields from their grandfathers.

The seed production of lucerne is concentrated to-day in certain regions, namely, Kayseri with Bogazleyan (Yozgat), and in addition Beysehir (Konya). For the east Anatolian region no definite centres of seed production are known to exist. We found a considerable amount of seed production near Erzerum.

In discussing the forms and varieties of Anatolian cultivated lucerne, we will summarize the results hitherto obtained from investigations begun in 1931, and carried on continuously by O. Tarman at our Institute.

There are, as is to be expected from what has been said, two large groups of forms, namely : (1) the east Anatolian group, (2) the central Anatolian group. The distribution of these groups is shown in Fig. 1.

The east Anatolian lucerne, of which Tarman (**8**) gives a detailed description, has proved in trials to be of perceptibly slower growth than the central Anatolian

lucerne (cf. Fig. 6). This fact was determined not only in spring development, but also after every cut. Its yield per cut is greater in this climate than that of the central Anatolian form. Further important characters determined by Tarman (**8**) were as follows : its growth habit is semi-erect (cf. Fig. 7), the inflorescences are capitate, it begins to flower—in accordance with its slower development in Ankara—approximmately eight days after the central Anatolian lucerne. In the years of trial the east Anatolian forms proved to be very drought-resistant. Wilting took place four days later than in Kayseri lucerne. In the spring of 1936 (which for Anatolian conditions was very wet, and in which wheat suffered a very heavy attack of yellow rust, such as had not been observed for decades) the lucerne varieties grown side by side for purposes of comparison showed in parts heavy attack by *Gloeosporium trifolii*, wherein the east Anatolian form proved to be to a considerable degree resistant. At the same time its general habit was hardly affected by the weather. Within the east Anatolian lucerne, Tarman distinguished three forms based on the colour of the petals and the veining of the standards.

The chief distinguishing character of the central Anatolian lucerne was found by Tarman to be : "a taller, erect growth habit (cf. Fig. 8), more rapid after-growth, stronger, erect stems, less branching, lighter leaf colour, and, on an average, larger leaves." Eleven forms were distinguished on the basis of petal colour and venation of the standards.

It is interesting to note that these forms are by no means regularly found in every variety, but that forms Nos. 1 to 8, as distinguished by Tarman, are found only in Kayseri lucerne ; in the Erzincan variety Nos. 6, 7 and 8 are lacking, but Nos. 9 and 10 are found. In Bursa varieties only Nos. 1 and 10 are found, and No. 11 is found for the first time. These observations give rise to the assumption that the flower forms represent not merely external characters, but that they are correlated to physiological peculiarities. The great selective action of the different climates in the districts of the individual varieties may thus have had an indirectly selective action upon flower colour. Comparison of the map with the climate table shows under what different growth conditions the various forms of central Anatolian lucerne exist. But as, in the case of the central Anatolian lucerne, it is a question of populations of many forms, the composition of the populations is bound to alter in accordance with the conditions of vegetation. Observations made in the spring of 1936 concerning the very unequal degree of fungous attack likewise indicate that the populations differ not only morphologically, but also in their physiological constitution.

Variety	*Degree of susceptibility*
Konya and Denizli	very great
Erzincan, Bursa	medium
Kayseri	slight

Experiments carried out in Germany with central Anatolian lucerne, Kayseri variety, confirm in the first place its rapid development and high degree of drought-resistance, and also the fact that the different varieties are not alike in their value for growing.

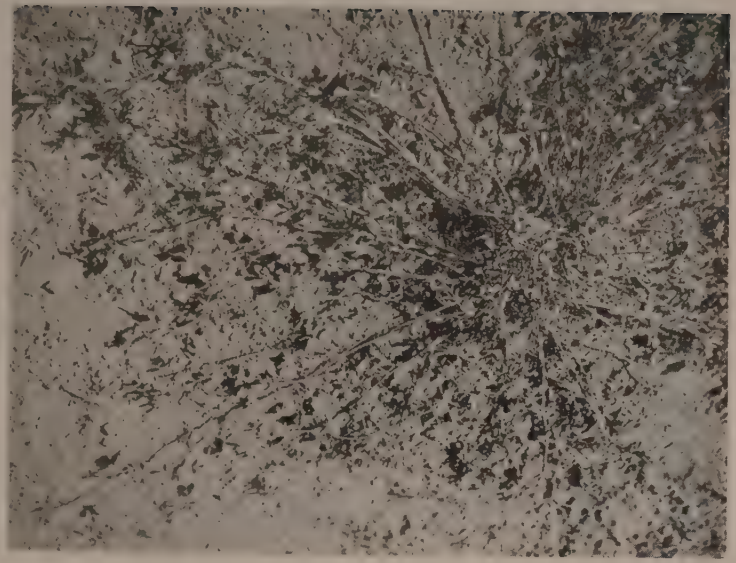

Fig. 5. Prostrate wild lucerne form.

Fig. 6. 143. East Anatolian lucerne. 144. Central Anatolian lucerne. Difference in the rate of development.

Fig. 7. East Anatolian lucerne, semi-erect.

Fig. 8. Central Anatolian lucerne, erect.

To face p. 64

Our present experience with regard to cultivated lucerne can therefore be summarized as follows.

The east Anatolian and the central Anatolian groups of forms must be distinguished from one another. In both there are forms which differ, not only morphologically, but also physiologically in their productivity. The east Anatolian lucerne develops more slowly, but appears to be resistant to many fungi or even quite immune; it is very winterhardy and at the same time drought-resistant. The central Anatolian lucerne has a greater abundance of forms ; the composition of the populations, is, in accordance with origin, different, and thereby the value of the different varieties is dissimilar. From what has been said, it is not possible to form a satisfactory opinion of Anatolian lucerne from the Asia Minor lucerne which was employed in the International Lucerne Test and obtained, according to Whyte (**10**), from Moscow without any definite indication of origin, especially if, as is probable, the seed was grown in Russia from the descendants of an Anatolian variety.

The results of the Ankara studies are sometimes in conflict with the findings of Bordakov (**11**). Tarman (**8**) discusses the different opinions in detail. We believe that the differences are to be attributed in the main to two causes. In the first place, considerably more material was at our disposal, and in the second place our trials were carried out in a climate which is correct at least for the central Anatolian lucerne. The east Anatolian form finds even in Ankara a climate which is very different from that of its region of origin. This is expressed, among other things, in low seed-setting. The same observation was made in the case of the central Anatolian lucerne grown in the lowlands near Bursa.

From what has been said it is clear that a great abundance of forms, both cultivated and wild, are at the disposal of the Turkish breeder. The objectives of breeding naturally differ considerably in the different regions. In central Anatolia three main objectives are to be distinguished : (1) a highly productive lucerne for growing under irrigation ; (2) a lucerne which will grow, even in central Anatolia, without irrigation under satisfactory soil water conditions ; and (3) a lucerne suitable for grazing in central Anatolia. The work, as laid down at the first Plant Breeders' Congress held in 1928 at Ankara (cf. Christiansen-Weniger (**12**)) ; was taken up by the different breeding stations and has already made considerable progress.

E. Yektay, Director of the Sazova Breeding Station near Eskisehir, has succeeded in breeding a lucerne for dry farming which, under suitable conditions, will yield two green cuts or one green cut and one seed cut, and in addition as much as eight tons dry hay per hectare. The work of Tarman also promises good results both in the production of a lucerne for dry farming and also a lucerne for grazing.

For the north-western coastal region and for Thracia, Gökgöl (**13**), of Yesilköy, is breeding a lucerne for dry farming. This will have not only to survive the summer droughts characteristic of this region, but also to exhibit a high degree of resistance to fungous diseases, for Tarman reports that in the summer of 1935 he tested at Karacabey, near Bursa, a lucerne field which was extremely heavily attacked by *Uromyces*.

TABLE 1.

Place	Precipitation								
					Annual Quantity				
	Autumn mm.	Winter mm.	Spring mm.	Summer mm.	Mean mm.	Max. mm.	Min. mm.	Years of observation	Rain factor
1. Istanbul-Göztepe	222	232	111	61	626	770	458	10	43
2. Edirne	154	175	125	100	555	842	328	13	40
3. Izmir	212	348	150	12	722	1134	419	11	41
4. Mugla	244	703	290	30	1259	2380	581	12	82
5. Denizli	84	175	134	29	422	502	294	5	28
6. Isparta	101	222	193	49	519	729	234	12	42
7. Antalya	190	682	128	27	1026	1930	552	9	61
8. Adana	113	270	159	43	584	943	343	13	31
9. Ankara	62	97	124	49	331	423	176	12	28
10. Afyonkarahisar	90	126	147	70	435	721	295	12	36
11. Sivas	97	109	153	38	396	605	298	8	43
12. Bolu	110	142	140	96	488	668	288	13	46
13. Samsun	202	217	155	114	687	916	610	10	47
14. Rize	828	765	385	549	2526	3555	1896	12	175
15. Malatya	85	129	111	20	346	365	239	8	27
16. Erzrum	107	101	186	118	512	800	325	10	65
17. Kars	96	95	175	170	536	720	402	9	72
18. Diyarbakir	87	199	136	10	496	670	357	9	32
19. Urfa	113	238	111	54	515	724	206	8	28

Relative Humidity			Temperature in Degrees Celsius						Number of Days		
	Monthly Mean		Mean for		Annual Mean						
						Absolute					
nual ean	Max. per cent	Min. per cent	Warmest month	Coldest month	Average	Max.	Min.	Annual variation	Summer	Frost	Winter
ricultural Region No. I											
4.1	79.1	69.5	24.1	4.8	14.5	38.0	−16.0	54.0	111	26	2
2.1	81.4	58.8	25.0	2.3	13.7	42.0	−18.0	60.0	134	59	8
ricultural Region No. II											
1.0	71.1	47.4	27.4	8.3	17.4	42.4	− 8.4	50.8	166	12	0.3
0.1	78.0	40.5	26.5	6.0	15.3	38.0	− 6.0	44.0	136	27	0.3
8.2	79.7	54.5	25.9	5.2	15.0	40.0	−10.8	50.8	158	36	0.3
3.5	75.8	45.8	23.5	1.6	12.3	37.0	−17.6	54.6	116	76	9
ricultural Region No. III											
7.9	72.0	58.5	27.7	10.1	18.4	43.4	− 4.5	47.9	165	2	0
6.6	71.8	61.8	28.7	8.8	19.0	42.6	− 6.2	48.8	199	1	0
ricultural Region No. IV											
7.3	78.5	37.8	23.7	−0.8	11.9	37.1	−21.0	58.1	117	92	16
1.6	77.6	46.7	22.8	0.04	12.2	37.0	−22.0	59.0	94	99	18
5.5	78.0	54.4	20.3	−5.7	8.3	35.0	−30.0	65.0	77	131	42
ricultural Region No. V											
2.4	78.4	67.6	20.6	−0.2	10.6	37.8	−29.0	66.8	92	101	16
ricultural Region No. VI											
3.3	80.2	67.3	23.6	6.5	14.5	35.4	−9.8	45.3	84	16	0.5
ricultural Region No. VII											
6.5	82.4	68.8	23.0	6.8	14.4	36.0	6.2	42.2	58	19	0.4
ricultural Region No. VIII											
—	—	—	27.1	−0.2	13.6	39.4	−17.0	56.4	130	77	18
ricultural Region No. IX											
—	—	—	19.8	−9.9	6.0	34.0	−29.0	63.0	58	158	82
—	—	—	18.3	−13.1	4.6	34.0	−35.5	68.5	54	180	84
ricultural Region No. X											
—	—	—	30.7	0.4	15.7	46.0	−24.2	70.2	172	70	5
0.0	72.3	31.0	31.2	4.9	18.6	44.0	−12.4	56.4	187	43	1

We have seen above how relatively little lucerne is yet cultivated in Turkey. The most rapid and wide extension possible of this culture is one of the main objectives of Turkish agrarian policy, for it is a question of making the fullest use of the "Queen of fodder plants" in regions which, as long as water is available, offer it very favourable conditions (cf. Christiansen-Weniger (**14**)).

To this it should be added that foreign demands for central Anatolian lucerne seed of the Kayseri variety already far exceed the present possibility of production.

Before the breeders can fulfil their task, it will be necessary to determine what is the most suitable variety for each region and to provide for an adequate production of good seed. As the Kayseri variety is that which is most widely useful and for which there is the greatest demand to-day, Government measures have been directed in the first place to the organization of Kayseri seed production, whereby it is ensured that the grower obtains a good price for his seed and is sure of a market. As only good seed is accepted, not only is the growing of seed greatly extended, but the grower is obliged to exercise care and to deliver a product of good quality. In addition a modern cleaning and seed control station for lucerne has been established in Kayseri. All the requisite conditions have now been fulfilled for the supplying of home and foreign requirements in the Kayseri central Anatolian lucerne with seed of high quality. Other varieties will follow. The east Anatolian lucerne is in the special charge of the Erzerum Breeding Station.

Summary.

1. The region in which Anatolian lucerne is grown exhibits very great climatic differences, which may exceed those of certain international trials.

2. Eastern Anatolia is part of the original home of lucerne.

3. The wild lucernes exhibit a great abundance of forms, increased to an extraordinary degree by the presence not only of *M. sativa* and *M. falcata* but also of the *media* forms.

4. Only *M. sativa* is cultivated. This species embraces two distinct groups of forms : (i) the east Anatolian lucerne, (ii) the central Anatolian lucerne. Each group has several forms, the second containing the greater number.

5. The individual varieties of the central Anatolian lucerne differ morphologically and physiologically.

6. In east Anatolian lucerne a high degree of resistance to *Gloeosporium trifolii* was observed in 1936. The central Anatolian varieties grown in comparison were slightly to very greatly susceptible.

7. The special objectives of lucerne breeding in Turkey are being pursued, with successful results.

8. The production of Kayseri seed is encouraged and controlled by the State, with a view to supplying the considerable home and foreign demand for this product. A modern cleaning plant ensures the unexceptionable external quality of the seed.

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THE FUNDAMENTAL FACTORS OF THE URUGUAYAN FORAGE PROBLEM*

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THE fundamental factors of the national forage problem may be divided into three groups: I. natural; II. technical; III. economic.

I. NATURAL FACTORS

THE factors soil and climate undoubtedly represent the cardinal point of the forage problem. Although in Uruguay both are on the whole favourable to the production of herbage, so that under natural conditions the country is a stock-raising land *par excellence*, certain deficiencies exist which require an increasing amount of attention in relation to the forage problem.

SOIL

The contour of Uruguay is, with the exception of the lowland plains, gently undulating, becoming more broken in the higher parts of the hill lands which traverse the country. There exist, therefore, the preliminary conditions for the advancement of those erosive processes by which—with every reason—similar pastoral regions in other continents are at present alarmed. In an address on temporary leys and natural pastures delivered at Paso de los Toros last year (**3**), reference was made to the prejudicial effects which have followed the destruction of large areas of virgin forest and pasture land in the United States of America, and to the damage caused—especially in recent years—through the mechanization of tillage by means of tractors, which produce excessive disturbance of the virgin soils and the destruction of what has been formed by Nature in thousands of years of adaptation. There is still fresh in our memories the damage caused to the great American cities through dust storms, the mortality among domestic animals through prolonged drought and the enormous losses caused by catastrophic floods in that country, all disasters related to irrational destruction of the plant cover over vast areas.

This rapid destruction of the soil, an irreplaceable part of the natural riches of a country, is an accelerated erosion which is quite distinct from natural erosion. The latter originates at some weak point in the plant cover, and depends upon climatic conditions, slope, and the character of the soil, and covers periods more or less pro-

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URUGUAY (Arrow indicates position of La Estanzuela).

longed. As long as there is no disturbance of the ecological equilibrium on a large scale, natural erosion does not necessarily involve destruction of the soil. Under natural conditions equilibrium is nearly always re-established, as, for example, in the formation of large tracts of fertile land based on the material which has been carried off, a well-known phenomenon which has contributed to the gradual formation of the steppes, and the effects of which may be observed at the present day in the formation of the peat lands. Under ecologically balanced conditions there is a natural conservation of the soil through the natural plant cover.

When a disturbance of the equilibrium between erosion and vegetation is made in favour of the former, there is initiated the accelerated erosion which results in a consequent ruin of the soil. The destruction of virgin forest at the source of the river systems, and an irrational form of agriculture which disregards prudential limits imposed by local conditions, provoke an accelerated erosion which represents one of the great problems of the age for western civilization. In Uruguay, as elsewhere, this class of erosion is familiar to any countryman who has seen the extraordinary amount of matter that is carried off from arable land by the increasingly prevalent torrential

rainfalls. But unfortunately accelerated erosion takes place in the grasslands also. Any destruction of the plant cover, even if only by a path or roadside ditch, by the burning of herbage on land which—on account of the physical structure of the soil—should not be burned, or, in worse cases, by over-stocking poor land having more or less loose soil, may start erosion resulting in progressive soil destruction.

This class of accelerated erosion is especially conspicuous in South Africa. The white man's colonization of vast regions of subtropical steppe (veld) having relatively poor soil and sparse vegetation, and the exploitation of this land for the extensive form of stock-raising imposed by regional conditions, have obliged the natives to live within more limited areas. In the native regions, therefore, there is an excessive number of the animals, cattle, sheep and goats, that represent the fortune of the inhabitants; and this excessive stocking produces a destruction, through grazing and trampling, not only of the sparse herbage of the veld, but also of its scattered trees. The violent rainfalls characteristic of this subtropical zone are thus enabled to carry off the sparse plant cover that has been deprived of the support of the roots, initiating a process of accelerated erosion hitherto unsurpassed. The damage is accentuated by the impoverishment of the soil in mineral substances which have been carried off to the streams or filter down through the permeable soil to the subsoil. And these are precisely the same phenomena as those which may be seen in Uruguay, where they have given rise to the "blanqueales,"* or white patches, found principally in land that has been under cultivation for many years. But the grasslands also are beginning to show signs of this process of calcium and phosphate impoverishment, together with the resulting diffusion of the osteomalacia which, in Uruguay as elsewhere, is beginning to constitute a serious problem.

Climate

Climate is equally affected by a disturbance of the ecological balance of vast areas. Reference has just been made to the continent of Africa, in the southern part of which there has been recorded a gradual drying up, with the danger of the formation of actual deserts. In the north also, the prolonged drought that has been castigating French Morocco for eighteen months is attributable to the destruction of ecological equilibrium.

The climate of Uruguay is characterized by great irregularity and pronounced extremes, especially as regards the quantity and distribution of rainfall. Conditions are not on the whole unfavourable for extensive ranching. A climate in general mild, with annual rainfall sufficient for the development of herbage, has allowed Uruguay to evolve a pastoral régime which places her in the foremost rank of meat-producing countries. At the same time prolonged estival drought and periods of excessive rain in winter are a reason for concern, since both characters present more or less serious obstacles to the intensification of stock-raising, especially as regards the improved quality so necessary at this epoch.

*" Blanqueales" are patches of land several metres in diameter, found on slopes, whence—generally as a result of long use as arable land—leaching has removed all organic substance, leaving a sandy, greyish, sterile soil.

The difficulties attending the modification of climatic conditions are much greater than those of measures for the restoration of soil degraded through erosion. Nevertheless both in North America and in Africa projects of vast proportions have been undertaken, designed mainly to modify extremes and to break the violence of the storms so fatal to the great plains deprived of forest protection. The reforestation of large areas, greater even than the whole of Uruguay, is the salient point of the North American projects. In Africa, in addition to the great reforestation schemes of the Government of French Morocco in the High Atlas Mountains, there are projects for controlling the river systems of the Congo, the Kunene, the Orange River, the Limpopo, the Zambesi, etc. It is planned in the first place to retain water in the source regions, a system of small dams reinforced by lateral, levelled furrows preventing the excessively rapid flow of precipitation to lower levels and producing an infiltration into the soil such as takes place in highlands with forest cover. In addition to this there are plans for the formation of great continental lakes, including the filling with water of the vast semi-desert region known as the Etosha in Ovambo, north of the South African possessions on the Atlantic coast. It is intended by this means fundamentally to modify climatic conditions in the adjacent zones, although opinion as to the efficacy of this costly experiment is by no means unanimous. The above projects are of interest in view of the possible formation, in the near future, of a great artificial lake in the centre of Uruguay, to be made by damming the waters of the Rio Negro in Rincón del Bonete, work which will probably afford interesting evidence as to the possibility of modifying climatic extremes.

The foregoing observations suffice to show the necessity of devoting increasing attention to the study of these natural factors, and especially to that of soil conservation. In addition to the constant vigilance necessary on the part of agronomists to prevent erosion assuming alarming proportions at the most threatened points, practical measures such as afforestation—in which, happily, an increasing interest may be noted—should be fostered.

II. TECHNICAL FACTORS

The objectives of modern stock-raising, namely, the production of "baby beef," intensive dairying, and the quantitative and qualitative improvement of sheep products (wool and carcases), bring to the fore the protein problem as fundamental in the national forage problem.

The Protein Problem

In modern agriculture efforts are directed to the obtaining of the greatest possible quantity per unit area, not so much of a given product such as wheat, flax, potatoes, sugar beet, etc., but of the respective alimentary substances, protein, gluten (quantity and quality), oil, starch, sugar, etc. In plant breeding there is a marked tendency to aim at increasing the percentage of certain substances in the respective crop plants, thereby increasing the production of these substances per unit area. The importance

of the protein problem for graziers in this country is readily understood when it is remembered that the natural herbage is composed mainly of grasses, whereas the legumes, which are the main sources of protein, form a smaller proportion of the sward. The difficulties confronting a wider distribution of lucerne, which gives such good results in the Argentine Republic, are well known. And even more difficult is the cultivation of the different *Trifolium* species which in colder countries represent the great natural source of protein. Happily in some parts of the country relatively large, spontaneous clover fields are formed in the cold season by two species of *Medicago*, *M. denticulata* and *M. maculata*. There should be mentioned also *Adesmia bicolor*, an indigenous legume growing wild in some parts of the country, and some other legume species found sporadically in the natural grazings. But the growth of even the most widespread legume species is limited to certain regions, and their practical value is still more reduced by their relatively short period of growth. There undoubtedly exists, then, on many of the country's ranches a shortage, and at times an actual absence, of proteins for animal nutrition. This deficiency, especially accentuated at certain seasons, is the aspect of the national forage problem which is in most urgent need of solution, above all in its relation to the obtaining of high quality products. The following are some of the most interesting steps that are being taken for the discovery of an answer to the problem, although no doubt years will elapse before any solution can be transformed into a reality for the country.

1. **Soil studies.** The National Commission for the Study of the Forage Problem has undertaken a systematic study and analysis of soils from all parts of the country. In each Department of the Republic one or more ranches have been chosen as a base for these studies, wherein it has been endeavoured to select lands which, in the opinion of persons familiar with the different Departments, are more or less typical of the respective regions. The valuable co-operation of the ranch owners in the study of other of the forage problem aspects also is acknowledged. Some hundreds of soil analyses have already been made for the determination of the following : pH (actual and potential respectively), coarse sand, colloids, humus, calcium, and phosphoric acid. A preliminary report has been published by the Commission's Technical Adviser, Professor G. E. Spangenberg (**15**).

Reference may be made here to attempts which are being made to restore fertility to the "blanqueales," or patches of degraded soil, by means of growing legumes. Experiments with lucerne in land of varying degrees of poverty were recently described by G. E. Spangenberg (**16**).

2. **Agrostological studies.** The same ranches serve as a base for the study of the sward of the various parts of the country. Plots, eleven by eleven m. in size, their number varying in accordance with the diversity of the pastures in the region concerned, have been fenced off and are cut every three months, the first time during the period March to May, the fourth time during the period December to February. The yields of the plots are correlated to the soil analyses to which reference has been made above. Meteorological records (temperature, frosts, rainfall) are kept on the ranches concerned, together with records of the stocking of the grazings. The last-

named records enable the agrostologists to note differences between the herbage mown by the scythe and that of the adjacent pastures which is grazed in the normal manner.

The cuts from the fenced plots are first studied for their botanical composition, the percentage of grasses, legumes, and other species being determined. A chemical analysis is then made for the determination of moisture, crude protein, crude fibre, fat, N-free extractives, ash, calcium, and phosphoric acid. Little by little the Commission is thus accumulating analytic material of singular value, which will furnish an exact basis for determining the influence of soil and climate on the quantitative and qualitative nature of the Uruguayan grazings, subdivided into distinct regions of markedly different productive character. These investigations are being carried out by the personnel of the National Commission, Professor G. E. Spangenberg, and Engineers J. G. Nores, L. A. Montedónico and C. A. Fynn.

Valuable independent studies, financed by Dr. A. Gallinal, on whose estates the work was done, have also been made by the Engineers J. P. Gallinal, E. F. Campal and L. Bergalli and the students L. Aragone and B. Rosengurtt (**6**). Their findings have been examined by Engineer T. Henry on behalf of the National Commission.

3. **Improvement of the natural grazings.** The soil and sward studies described above provide a point of departure for practical measures of improvement, an important part of which concerns the control of weeds and the reduction of the proportion of poor grasses, such as *Piptochaetium*, *Stipa papposa*, etc., which are spreading to an alarming extent in some parts of the country. Professor G. E. Spangenberg has published a considerable amount of information on the subject of improvement (**12-15**).

4. **Forage crop production.** The natural conditions of Uruguay render forage crops of special importance in replacing the natural grazings in winter and in summer respectively, but the compact soils, difficult to work both in the prolonged rainy season of winter and when hardened by drought in summer, render their production more costly than in the case, for instance, of the loose, permeable soils of Argentina. Nevertheless, on progressive ranches and on dairy farms the area occupied by forage cereals, Sudan grass, and other forage crops is steadily increasing. Of the forage cereals, oats are most generally grown, and the Plant Breeding Station at La Estanzuela has produced some valuable strains. Forage barley is also grown, and wheat, the first growth of which is grazed, the aftermath used for grain. Of increasing importance is the use of Sudan grass for summer feed, especially on the dairy farms, and scientific research into the HCN problem connected therewith is in progress (**4, 10, 11**). Reference is made to an article by T. Henry on the subject of forage crop production in Uruguay (**7**).

5. **Forage foresight.** This takes the form principally of fostering the practice of ensilage, especially on the dairy farms. Information on the Commission's activities in this respect has been published by L. A. Montedónico (**8**) and G. Nores (**9**).

6. **Adaptation of new species.** Apart from plants already acclimatized, lucerne, Sudan grass, Rhodes grass, Grohoma sorghum, and others, a large amount of material

is at present undergoing examination at La Estanzuela. Of particular importance are the legumes *Vicia*, *Lupinus*, and *Lespedeza*. As a result of several years' work with *Lupinus albus*, there has been obtained in 1938, for the first time, a good seed crop, furnishing a reliable basis for the introduction of this plant. Among the different *Lespedeza* spp. studied, types have emerged which appear to adapt themselves to Uruguayan conditions, so that it is hoped to obtain a legume suitable for the relatively common, slightly acid soils in which other legumes do not thrive. On the ground of favourable results obtained in La Estanzuela trials, the Commission is having seed of the above-named species distributed. It is to be followed later by seed of other species, including *Vicia sativa*, in which the dairy farms of the south display a considerable amount of interest.

More detailed information on this work is given on p. 338 of the author's retrospect of plant research and improvement in Uruguay, 1938 (**2**).

7. **Breeding forage plants.** It has been necessary to concentrate in the first place upon those plants already of some importance in Uruguay, oats and other forage cereals, then lucerne, and recently Sudan grass also. La Estanzuela strains of oats (1095a), of barley (702a) and of wheat (Rieti) represent an important conquest for the country's forage production. In addition, work on the evolution of a genuine Uruguayan lucerne type is advancing through the formation of clones; and A. A. Bonjour is working on the production of a Sudan grass practically free of hydrocyanic acid. Work of a more qualitative nature, for example, the increasing of protein content or content of other nutritive substances, is as yet obliged to take, together with purely genetic study, a secondary position.

8 and 9. **Research and experiments in animal nutrition.** At the Sayago Model Farm, Engineer J. de l'Harpe is making a study of the digestibility coefficients of various fodders. Trials which have been conducted with various classes of animals and various types of grazing, green fodder and rations, including silage, have been reported in the literature. Articles to which reference is made include work by Engineer G. J. Fischer and others (**5**), and by J. Spangenberg (**17**).

10. **The osteomalacia problem.** Attention has been drawn in a previous work (**3**) to the gravity of this problem in certain parts of the country where the soil is deficient in phosphates and lime. The problem is actually a universal one, originating in the march of a civilization which not only concentrates its populations in great urban centres, but in which the exporting of animal products to overseas markets continually withdraws from the land phosphates and lime which are never replaced. The result is a disturbance of the balance between ecological and biological forces; between the productive capacity of the land on the one hand, and on the other the animal substance derived from it but not returned again.

The scale of susceptibility in domestic animals is as follows: cattle (the most susceptible), sheep and goats, horses and pigs. During the past year the Forage Commission has imported from Argentina 20,000 kg. of a product named "Phosphosal" and composed of calcium phosphate, sodium chloride, iron, and potassium iodide, and has distributed it among the ranches situated in the osteomalacia zones.

The results obtained have been conclusive ; in every case where it has been used the disease has disappeared and the development of the animals has been normal. The regions affected by osteomalacia include Rincón de Ramirez in the Department of Treinta y Tres, the third section of the Department of Cerro Largo, and the Pandule and Piedras Coloradas zone in the Department of Paysandu ; for such regions the discovery of an effective control of the disease is of great importance. The cost of employing the mineral lick described is approximately $0.60 per head of cattle per annum, which—in view of the benefits obtained—can well be borne by the rancher.

The other solution of the osteomalacia problem, namely, the application of phosphatic fertilizers to the enormous grazing areas that are deficient in this substance, is necessarily ruled out on economic grounds.

III. ECONOMIC FACTORS

1. **Degree of intensity.** The management of Uruguayan ranches and farms is of a threefold nature : (a) extensive management, such as that of the great ranches ; (b) semi-intensive, as on estates where not only are the natural grazings used, but forage crops also are grown ; (c) intensive farming, such as that of the dairy and mixed farms, where the growing of forage crops is of relatively greater importance. It is obviously impossible to advise the same methods of improvement for a pastoral establishment situated in the north of the Republic, far from markets and dependent on inferior soil of poor stock-carrying capacity, and for a small farm in the south devoted to milk production or mixed farming.

2. **Markets** similarly influence initiative in the direction of grassland improvement. If the value of wool is insufficient to repay the rancher for his invested capital, he is unlikely to take steps to increase and improve a product for which there is no demand. The preference of the markets for " baby beef " has recently accentuated the forage problem for the grazier, because, if this high quality product can be economically obtained, its supply holds out the possibility of making great profits. Proximity to markets is a further factor to be taken into account, of special importance for the dairy farms, but of importance also for the larger ranches.

3. **Net profits.** In the last instance it is the net profits obtainable which decide the rate of improvement. Much caution must be exercised in the extension of forage crop cultivation, for there have been cases where—under the "extensive" management typical of vast regions in Uruguay—the breaking up of the land has not only brought no immediate profit, but has entailed the eventual degradation of the soil. In a previous address (**3**) it was shown—in the convincing language of figures—that by good management there may be obtained from our natural pastures a net profit considerably superior to that obtained from an approximately equal area of lucerne in the Argentine Republic. In the instance cited there was a direct basis of comparison in regard both to management and to book-keeping, and definite proof was given of the good quality of the Uruguayan grazings when rationally improved in accordance with local circumstances.

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REVIEWS

PASTURE RESEARCH AND EROSION CONTROL IN SOUTH AFRICA

[Reviewer : M. HALL]

Following the adoption by the House of Assembly in May, 1934, of the Resolution " that the Government be requested . . . . to take the necessary measures to prevent the drying up of the Union and in general to preserve the waters of the Union and to prevent by legislation or otherwise unnecessary veld burning in the mountains," the programme ultimately prepared by the Division of Plant Industry stressed the fundamental importance of research on veld management and reclamation as a key to the problem. This report* records the progress of the work put in hand and carried out to date.

J. R. Rowland, in the introduction, outlines the economic conditions which prevail and necessitate reliance on natural veld grazing for stock. To meet this need veld degeneration must be prevented. Initially development can result only from intensification of small areas on each farm, with large, undeveloped regions providing the bulk of the farm's feedstuffs. In the meantime studies are in progress and they may be grouped under the following headings : (1) survey of vegetation types and farming practice ; (2) veld management ; (3) veld reclamation and burning ; (4) artifical and irrigated pastures ; (5) fodder conservation ; (6) seed supplies of pasture plants, and (7) systematics of fodder plants.

THE TOWOOMBA PASTURE RESEARCH STATION

This Station is located near Warmbaths, Transvaal, on an area which is characteristic of the Middleveld in vegetation and soil type. Cattle ranching is the main farming industry of the bushveld and there is need for information that will aid the farmer in stock management under the exacting and erratic climatic conditions. The sweetveld is suitable for winter grazing and the large areas of sourveld on the Waterberg are suitable for summer grazing, but the settlers keep their stock on both types all the year round. To obviate the consequences of this malpractice, investigations are in progress on (1) the carrying capacity of veld and response of the veld to various methods of management at different times of the year ; (2) the revegetation of denuded grazings and old fallows, including methods of bush eradication ; (3) edible shrubs, trees, grasses and legumes grown in the nursery for tests of feeding value and suitability in bushveld country ; and (4) survey work.

Details of these experimental programmes are given in subsequent sections with the following headings :

1. A preliminary survey of the existing agricultural conditions, and the possibilities thereof in the Northern Transvaal, by L. O. F. Irvine.

There are four main vegetation types : (a) the low and (b) middlevelds (together constituting the bushveld) ; (c) the Waterberg and Zoutpansburg sourveld ; and (d) the semi-highveld. These types are distributed in relation to elevation and soils but variation within the type is due to the influence of climatic and biotic factors. The

*Union of South Africa, Department of Agriculture and Forestry.
Progress Report No. 1. Pasture research in South Africa. Pretoria, 1938. pp. 162. pls.

history of the bushveld vegetation leading to ultimate degeneration is traced and details of the different veld types are supplied. It is noted that the potentialities of sections in the Northern Transvaal were originally complementary and that the practice of the early "Trekboer" followed the natural system of usage. Of the above four types of vegetation (a) and (b) constitute the sweetveld (suitable for winter grazing), (c) is suitable for summer grazing, and parts of (d) together with the Springbok Flats are suitable for the production of crops. Three policies are outlined from which choice will have to be made in the future. The scheme whereby each farm is organized as an "all the year round" unit, although not the ideal plan, will probably be adopted and in this policy farmers, technical officers, railway administration and the Government should participate.

2. Veld reclamation problems in the Transvaal Bushveld, by J. D. Scott.

Three of the main problems presented in the bushveld and studied at the Towoomba Research Station are (a) to re-establish good grazing conditions on veld denuded of its original grasses; (b) to find a cheap method of eradicating encroaching thorn scrub which is inedible and to determine the effects of fire on the veld; and (c) to reclaim abandoned areas for useful grazing. (Fig. 8).

(a) *Reclamation of denuded veld.* The first experiment was designed to determine whether veld would recover under absence of grazing and by (i) rest alone, (ii) by reseeding, (iii) by loosening the soil, and (iv) by planting grasses. The trials were made on denuded veld consisting of large, bare patches between areas covered with *Aristida* spp., *Eragrostis* spp., *Tragus racemosus*, with occasional remnants of *Eragrostis superba*, *Themeda triandra*, *Brachiaria nigropedata* and *Cymbopogon* spp. Seventeen treatments were applied, fifteen of which had direct bearing on the problem and two dealt with the effects of veld burning on such areas. While as yet no definite conclusions are drawn, it is noted that veld which is merely protected from stock and fire recovers rapidly and loosening the soil with a Lucerne King Cultivator has a beneficial effect on the sward.

The second experiment was made to determine whether veld badly trampled would recover under certain grazing systems. Results show that winter grazing with summer rest is beneficial to the veld and recovery of cover and species is good. Grazing in early summer one year and in late summer the next, and grazing-mowing in alternate summers resulted in fair recovery. Grazing all summer is definitely deleterious.

(b) *The problem of bush encroachment.* Data are recorded from three experiments made which involve (i) sodium chlorate sprays and/or felling and burning at different seasons, (ii) systems of grazing and burning, and (iii) hand clearing.

(c) *Reclamation of old lands.* Two experiments are in progress: (i) various treatments have been applied to discover whether the poor cover is due to lack of fertility, and whether a good grass cover can be induced by seeding, planting, complete rest or mechanical loosening; (ii) a number of grazing treatments combined with different seasons of rest have been initiated.

3. Veld management research in the Bushveld.

The investigations being made are along two lines: (i) veld production, including various systems of grazing, fertilizing, resting, etc. Methods of sampling and grazing are investigated as noted on p. 84. (ii) Herbage utilization, including effects on the sward and quality of ration utilized. Further details of veld utilization experiments are given on pp. 84. et seq.

Athole Pasture Research Station

The Station is situated between Amsterdam and Ermelo. Vegetation of the district consists of tall grass veld, and is typical of large areas east of the Drakensberg.

The whole livestock farming system is based on the practice of veld burning which entails incomplete utilization and wastage of more than 50 per cent of the herbage produced. The effects of heavier stocking are also disastrous and studies are being made to determine how this may be obviated. (Cf. Fig. 6). The work includes experiments on veld mowing, methods of herbage conservation and veld management in addition to studies on the effect on soil and plants of burning, grazing and mowing.

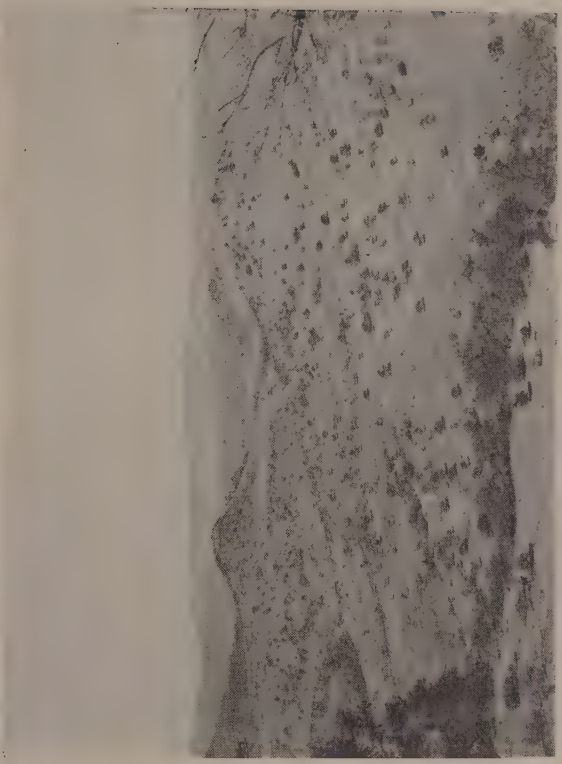
In an account of sourveld management, J. W. Rowland stresses the need for extending the capacity of the veld to provide a ration throughout the year. Characteristic problems of each season must be solved. Hitherto more satisfactory utilization of the sourveld has been achieved only in those districts where soils and climate are suitable for arable farming. Pastures for winter grazing (both dryland and irrigated), hay grasses and summer artificial pastures are under investigation. In the study of more efficient utilization of the veld the *fixed herd experiments* are notable. A certain area is grazed by a constant number of animals throughout the period of trial. A fixed rate of grazing is imposed on the area, regardless of season or the rate at which the area produces grass. Each week during the growing period, and every three weeks during winter, the herbage is analysed for determining the quality of the ration. Records are also kept of animal weights. The influence of various treatments on the actual yield of feedstuffs per area is studied in the *camp experiments*. These trials differ from the fixed herd experiments in the fact that, (under the different treatments of fertilizing, cultivation and resting), defoliation rate is varied to meet fluctuations in growth rate.

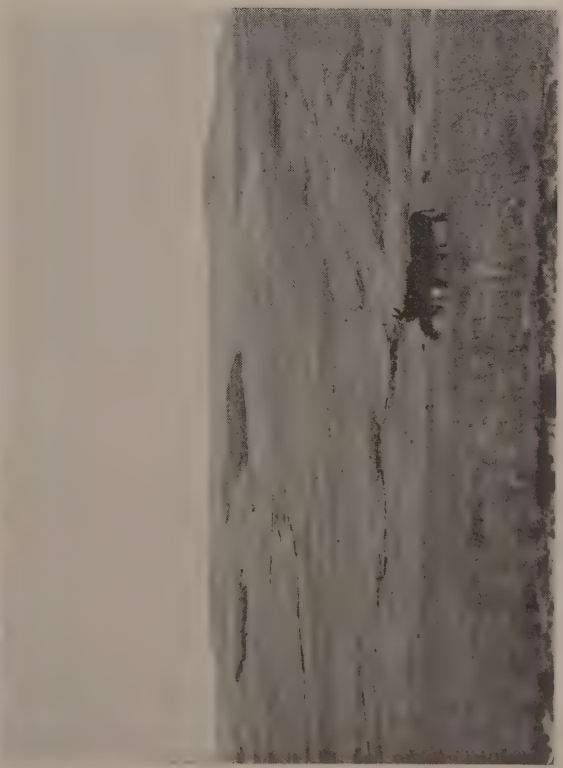
It is maintained by J. D. Scott in the section on veld burning that to determine the effects of burning, each locality must be studied separately in regard to conditions of climate, soils and vegetation. Two experiments have been initiated at the Athole Station with this object in view. The first is designed to show the effects without grazing of (1) complete protection from fire, (2) burning at different seasons and intervals and (3) mowing instead of burning. The second experiment is made to determine the effects of grazing combined with mowing and burning.

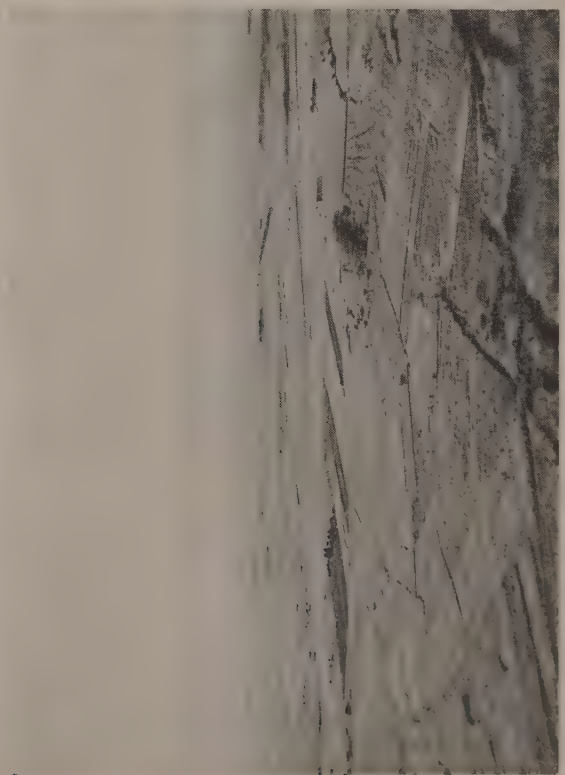
Investigational work which is being carried out in the nursery is reported by J. H. Preller. Of indigenous grasses *Themeda triandra*, *Hyparrhenia Buchanani*, *Setaria nigrirostris* and *Paspalum dilatatum* are the best. *Festuca scabra* is a promising winter grass. Species of *Digitaria* and other grasses from other localities are included in the tests. Forty-two exotic grasses, lucernes and clovers were sown in autumn, 1936. These are discussed under the headings *Lolium*, *Festuca*, *Phalaris* (*P. tuberosa* has proved the best type of winter grass), *Holcus lanatus* and *Dactylis glomerata* (promising winter grasses), *Medicago sativa* (Provence variety is the best, but there are signs of chlorosis), *Trifolium* (*T. subterraneum* is the best) and trefoils (*Lotus* spp. and *T. procumbens* are slow and poor).

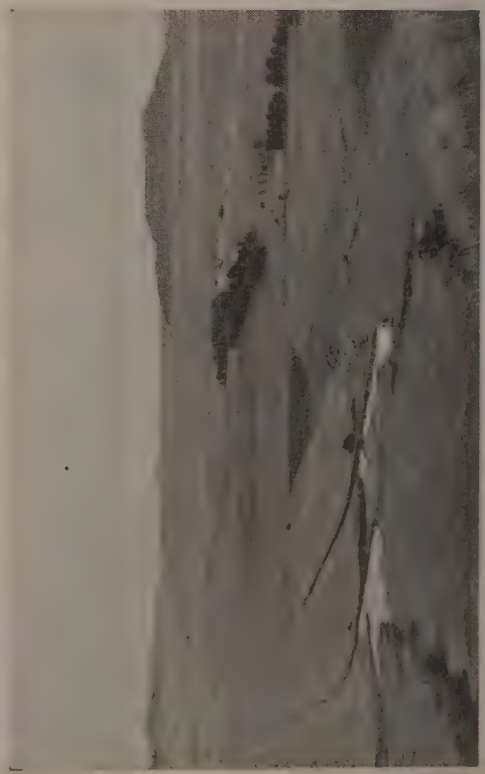
The programme of Athole veld management experiments is described by J. W. Rowland. A specified number of animals is grazed on each area of definite size for the period of investigation. Botanical analyses are made at the beginning of each experiment and at regular intervals throughout the grazing period. The herbage is sampled and analysed for feed constituents. The summer grazing experiments involve continuous and rotational grazing with variation in rest periods and/or combinations of burning and fertilizing. Winter grazing trials consist of variations in grazing after summer hay cuts, burning tests and studies of winter carrying capacity, while spring grazing experiments on veld which cannot be mown include burning

FIG. 1.—North Eastern Cape: mountainous country in N.E. Cape. FIG. 2.—Natal: Estcourt Pasture and Reclamation Research Station. View showing Laboratory, Foreman's Quarters and Thorn Veld. FIG. 3.—Natal: Sour veld. FIG. 4.—Natal: Typical thorn veld in good condition.









at different seasons with no burning as control. Comments are made on the few trials which have so far produced results. Finally two experiments on veld production are described. These are designed to determine effects of various seasons of grazing and resting on veld production and stability, together with effects of various treatments (fertilizing, mowing, cultivation, sowing of sweet grass seed) on veld under different grazing conditions.

Leeuwkuil Pasture Research Station

The main industry in the district is maize farming. Most of the land has been under crops at some time, and there are large patches of worn-out land covered by *Aristida*, *Cynodon* and *Eragrostis*, but as these patches become older they grade into almost pure *Themeda* veld. The more productive natural veld is being ruined by heavy and unsystematic grazing. Problems studied in the Maintenance Experiments include the effect on veld of grazing at different seasons, and methods of grazing or conserving fodder during the periods when the veld is most liable to be damaged.

In connexion with the establishment of useful pasture on fallows where re-seeding with *Themeda* is being carried out under various conditions, small-scale experiments, described by R. Storey in the section on Phytometry, are made to determine (a) the climatic and edaphic factors which differ in adjacent parts of virgin veld and fallowland ; (b) their effect on germination and growth of *Themeda triandra* and *Aristida barbicollis* ; and (c) means by which these factors may be varied on a large scale to help the growth of *Themeda* and hinder that of *Aristida* on old fallows. Further projects described by R. Story include preparation of compost, nursery experiments with thirty planted grasses, fodder conservation, and vlei development (improvement of natural vlei for hay, establishment of artificial pasture).

A programme of reclamation experiments designed by J. D. Scott includes investigation of the effect of (1) various treatments, (2) grazing at different times of the year on old fallow lands, and (3) green manure planting as a preliminary to establishing pasture on old fallows.

Grazing management experiments are designed by J. W. Rowland. They include various systems of treatment of the natural veld which is uniform in type with *Themeda* constituting 80 per cent of the grasses. Certain conclusions have been drawn and comparisons made.

Pasture Research at Pretoria

The Progress Report contains a preliminary account of the 'Vermeerbos' (*Giegeria* spp.) problem in Griqualand West (spread of the pest results from overstocking) and this is followed by a description of Pasture Research at Pretoria.

This work is planned as follows :

1. Preliminary investigations of the sources of pasture seed supplies, and of the possibilities of commercial exotic clovers and grasses on the pasture research stations.
2. A statistical investigation of the accuracy of the method of the clipped quadrat productivity sampling in use at Rietondale, Pretoria.
3. Systematic botany of fodder plants.
4. Veld reclamation work in the Donkey Camp, Pretoria.
5. Grazing management investigations at Rietondale.

With regard to item 3 an herbarium is being formed for the collection of specimens (particular attention being given to the grasses) which are obtained at different

Fig. 5.—Natal : Typical view of Tall Grass Veld, showing land under cultivation wherever possible. Fig. 6. Natal : Tall Grass Veld with typical donga (gully) erosion between lands owing to stock concentration on the hills above. Fig. 7.—Orange Free State : Contour banks on Mr. Hobson's farm, Vinies Siding. Fig. 8.—Transvaal : North Transvaal Bushveld.

stages of their growth. By this means it will be possible to identify plants at any growth phase.

Reclamation of veld in the Donkey Camp, Pretoria, is described by J. D. Scott. The work includes research on erosion problems with special regard to the value of certain grasses in soil binding, and on management. Results so far obtained indicate that the loosening of bare, eroded areas increases permeability of the soils and improves germination conditions for seed. Results of reseeding experiments have been published (*Herb. Abstr.* 8. Abs. 934. 1938).

Grazing management investigations were started in December, 1934, at Rietondale. There is indication that (1) only a small proportion of the herbage produced each year is grazed by stock except during droughts and in those cases where veld is overgrazed; (2) veld responds immediately to sound systems of management; (3) there is increase in yield due to fertilizer and compost treatment. Seasonal fluctuations in feeding value and quantity of herbage are being ascertained from veld and artificial pasture under treatment.

A note on experimental methods employed in grazing management research stresses the need for a standard technique and for the avoidance of applying technique which has succeeded in crop experimentatior in high rainfall or temperate climates to conditions which prevail in South Africa. This is followed by a description of the technique of sampling for quantitative and qualitative information on pasture yields. Experiments in veld utilization involve three tests, described, in which there is (1) continuous grazing of veld, through early spring onwards on an area of 5 acres; (2) rotational grazing of veld through spring and summer on an area of 5 acres, divided into eight equal-sized camps; (3) controlled grazing on an area of 5 acres divided into six camps of different size. There are indications that sward will deteriorate under system (1). The herbage in experiment (2) after one season shows no sign of destruction. A satisfactory scheme of grazing has been worked out as a result of experiment (3).

Other experiments described include: A, winter grazing trials, started in June, 1936, to determine what nutritional level could be achieved by grazing perennial unfertilized vegetation in winter; B, tests of the capacity of veld to produce herbage, and the influence of various treatments on such production (effect of fertilizers, mowing and reseeding on veld grazed in different ways; effects of grazing and resting at different seasons). By combining fertilizer and grazing treatments there is a potentiality for increase in production to exceed 300 per cent, and veld is considered to compare favourably with artificial pasture in its capacity to produce feedstuffs. C, simultaneously with the above work an investigation of seven different artificial pastures (including species of *Digitaria*, *Panicum* and *Setaria*) is in progress to ascertain their capacity to produce feed at different seasons of the year under different systems of winter and growth-period grazing. The information available shows that it is uneconomic to rest a pasture throughout the summer to provide winter grazing.

Estcourt and Tabamhlope Pasture and Reclamation Research Stations

Two research stations have been established in the catchment areas of the Tugela and Bushmans' rivers, one partly in thornveld and partly in tall-grass veld and the other in the highland sourveld (Figs. 2, 3 and 4). Farming systems are discussed in relation to reclamation and potentialities of the areas from a stock point of view.

The work in progress is classified as follows: reclamation and water conservation,

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Fig. 9.—Griqualand West: Sandveld in a valley of the Asbestos Hills near Niekerk's Hope. *Aristida* spp. with *Acacia giraffae* Burch., *A. haematoxylon* Willd., and, around the bases of the hills, *A. detinens* Burch. Fig. 10.—Griqualand West: Escarpment of the Kaap Plateau at Doringbult—limestone and dolomite.

veld management, artificial pastures, fodder conservation and compost making. The stations have been established comparatively recently and no results are yet available.

Erosion Control in South Africa

Of direct interest in connexion with the foregoing review is the report of the progress made in erosion control.* In 1929 a Soil-Erosion Conference was held under the auspices of the Department of Agriculture and Forestry and an Advisory Council was formed consisting of representatives of various farming organizations, interested State Departments and the Provincial Administrations. At a meeting of this Council in 1933, approval was given to the action of the Department of Agriculture and Forestry in regard to the undertaking of research work by the Department and by Universities in connexion with vital matters such as veld burning, pasture improvement and veld management. In regard to veld burning the Division of Forestry has revised the herbage-preservation laws and the draft bill is being studied. Progress made in pasture improvement and veld management in the Drakensberg area, together with research undertaken by the Division of Plant Industry (under the Control of the Department of Agriculture and Forestry) are described in the above review and an outline is included in the erosion report.

At the instance of the Division of Chemistry, which is also responsible for soil surveys, erosion engineers are collaborating in the work of preparing an erosion map of the Union. It is hoped that this work will be completed within the next two years.

Research undertaken by various Universities, which have received grants from the Department for this purpose, may be tabulated as follows :

University of Pretoria. 1, Study of moisture losses by vegetation ; 2, effects of fertilizing veld grazed rotationally by sheep ; 3, comparative productivity of *Chloris gayana*, *Digitaria Pentzii*, and natural veld ; 4, effects of seasonal over-grazing on veld ; 5, study of the critical growth periods of veld species ; 6, effects of different types and different degrees of intensity of defoliation on veld ; 7, effects of the time and duration of rest periods on veld. (This experiment is being repeated on the Witwatersrand University Farm at Frankenwald) ; 8, effects of different methods of utilizing woolly-finger grass as a sheep pasture ; 9, effects of fertilizing on Rhodes grass ; 10, effects of seasonal over-grazing on Rhodes grass ; 11, effects of different types and different degrees of intensity of defoliation on Rhodes grass ; 12, productivity of Rhodes grass in terms of beef ; 13, effects of cultivation of Rhodes-grass pasture ; 14, effects of different degrees of intensity of grazing on woolly-finger grass ; 15, effects of different methods of grazing and varying rest periods on the growth and quality of woolly-finger grass for winter grazing ; 16, effects of fertilizing on woolly-finger grass ; 17, a study of the water relations of *Themeda triandra* (rooigras) ; 18, effects of mowing and burning in a system of veld management ; 19, effects of varying methods of defoliation on a Rhodes-grass pasture ; 20, effects of cultivation on a veld sward ; 21, effects of seasonal mowing on a veld sward.

University of Witwatersrand. Studies are included of veld types, methods of investigation, life histories of veld grasses, plant succession and veld management with or without chemical fertilizers, pasture establishment, veld burning, over-stocking, old fallows, and the role of termites in veld life.

Potchefstroom University College. Botanical investigations are in progress in regard to certain grasses.

*South Africa, Department of Agriculture and Forestry. Soil-erosion control in the Union. Review of the progress made in soil-erosion control, more particularly of the work carried out by the various State Departments. Pretoria, 1939. pp. 36.

PLANT COMMUNITIES OF WESTERN QUEENSLAND

[Reviewer: M. Hall.]

An accurate survey of the pasture lands is a prime necessity in Queensland, where national wealth depends to a large extent on the grazing industry. In former publications (notably those of Prescott, Bull. 52, Coun. Sci. Ind. Res. Aust. 1931 and McTaggart, *Herb. Abstr.* 6. 334. 1936 and *Herb. Rev.* 3. 136-51. 1933), Australia was dealt with as a whole and Queensland was inadequately treated. An attempt has been made in the paper under review* to describe the important plant communities of Western Queensland in an area which covers nearly 330,000 square miles and includes the greater part of purely pastoral Queensland, with the exception of the large region surrounding the Gulf of Carpentaria. The study is based on field work carried out in connexion with general botanical investigations on pasture problems. After consideration of climate (the greater area lies within the 20 inch isohyet, while in the far south-west the average annual rainfall is below 6 inches), topography, soils, river systems and available water, it is noted that the major factors influencing the vegetation are soil type, incidence of rainfall and drainage. Drought-tolerant species have a wide geographical range, but as winter rains increase towards the south there is a marked change in floristic detail. Man and his grazing animals have produced distinctive communities which are classified as induced (after Cockayne) as distinct from primitive.

Primitive Communities

[In this review description of (5) fringing forests, (8) communities of the sandhills, and (12) communities of the bore-drains, is omitted.]

1. *Grasslands.* These fall into three groups: (a) Blue grass country with *Dichanthium sericeum* dominant; (b) Mitchell grass country with *Astrebla* spp. dominant; and (c) *Triodia* grasslands. The Blue grass country is characteristic of the better rainfall areas. Grasses and legumes which occur include *Dichanthium* and closely allied forms, in addition to species of *Bothriochloa, Paspalidium, Panicum, Digitaria, Thellungia, Indigofera* and *Neptunia.* Among other species is *Ixiolaena brevicompta,* highly esteemed as a fodder plant. Pasture degradation results in the progressive dominance of the comparatively worthless *Panicum decompositum* with *Aristida leptopoda.* The *Astrebla* country consists of plains and rolling downs. In much of the area trees are prominent and the following are useful fodders: *Atalaya hemiglauca, Ventilago viminalis, Acacia homalopylla, A. pendula, Owenia acidula, Flindersia maculosa* and *Apophyllum anomalum.* Under certain conditions *Atalaya hemiglauca* may be poisonous. Characteristic grasses are, in addition to *Astrebla* spp., *Eulalia fulva* and *Eragrostis setifolia. Dichanthium sericeum* occurs in areas with better rainfall. Perennials and ephemerals present between the grass tufts belong to the families Chenopodiaceae, Malvaceae, Leguminosae and Compositae. The value of the pasture depends largely on the annual and sub-perennial vegetation. In mixed pasture the Mitchell grass is not grazed until other members of the pasture have been eaten. There is evidence in some localities that pure Mitchell grass has little fattening value. The *Astrebla* grasslands are divided into three groups characterized by differences in soil type, dominant species of *Astrebla,* nature of the chenopods, if present, and reaction to stocking, etc. These groups are described in

*Blake, S. T. The plant communities of western Queensland and their relationships, with special reference to the grazing industry. *Proc. roy. Soc. Qd.* 49. 156-204. 1938. maps. pls. [Received Jan. 1939].

detail and figured. The final grassland division, namely, *Triodia* grasslands, is described in the next section.

2. *Triodia communities* (Spinifex country). This genus, widely known as spinifex or porcupine grass, is not to be confused with the genus *Spinifex*. The less pungent species have a distinct fodder value, dependent on their extreme resistance to drought and the readiness with which they put forth fresh growth after rain or burning, and the grain is an excellent stock food. The species do not occur mixed as a rule, but alternating stands are common. The more important major communities (described) are (a) the grassland community of the north-west; (b) the *Eucalyptus pallidifolia—E. leucophylla—Triodia* community (mountain gum-spinifex country); (c) extensive *Triodia*-dominant communities on the hills of desert sandstone, except in the south and south-east; (d) the spinifex sand-plain of the south-west (the occurrence of parakeelya [*Calandrinia* spp.], a famous fodder with thick fleshy leaves on which stock can subsist for some time without water, is notable); (e) an ill-defined community, east of Barcaldine, in which *Triodia pungens* and *Eucalyptus papuana* are associated on sand; (f) communities of silt beds; and (g) communities of *Triodia Mitchellii* and allied species.

3. *Regional forests.* Description is given of forests and related communities which occupy fairly extensive and continuous areas. There are three types: (a) Eucalyptus forests and parklands, (b) *Callitris glauca* forest, and (c) *Cadellia pentastylis* forest. These are described in detail, together with herbage of the forest floor, and the following species of high fodder value are recorded: *Pittosporum phillyraeoides* (cattle bush), *Sterculia diversifolia*, *Geijera parviflora* (one race freely eaten by stock, the other ignored but apparently inseparable morphologically) and *Eremophila Mitchellii* (appreciated by stock in some places).

4. *Scrubs.* These are widespread in Western Queensland and while in many parts they possess varied composition, in most areas they consist of nearly pure stands of *Acacia* spp., with or without a definite ground vegetation. The more important scrub-forming species are: *Acacia Cambagei* and *A. Georginea* (the latter community is considered fatal for cud-chewing animals at certain times of the year, and the poison has been attributed to a saponin or related substance present in young leaves and pods but absent in old leaves), *A. Shirleyi*, *A. aneura* (constitutes a valuable reserve fodder in times of drought, but some forms are readily eaten and others avoided), *A. cyperophylla* (considered an excellent stock feed in South Australia), and *A. harpophylla*.

6. *Communities of the channel country.* A fringing forest is present along the deeper channels, but in the open country between them characteristic communities are developed which are almost entirely herbaceous and often entirely annual. Their existence depends chiefly on the extent of the periodic floods. After excessive flooding the vegetation forms a fine fattening pasture, the floristic detail of which is imperfectly known. The two chief grasses are *Echinochloa Turneriana* and *Panicum Whitei*.

7. *Communities dominated by Chenopodiaceae.* Several of the species are long-lived, compact shrubs, and many are annual or short-lived plants, usually bushy in habit. Several of the latter enter into the formation of communities which are the degradation products of heavily over-grazed country. Thus they are actually induced communities. Two types of *Atriplex* communities are to be found, that of *A. nummularia* (leaves and young shoots very palatable) developed near or on flooded ground, and the rare *A. vesicaria* community, where the salt bush is dominant due to the removal by horses of the associated Mitchell grass. Blue bush (*Chenopodium auricomum*) and *C. nitrariaceum* form communities under somewhat swampy conditions. Among other communities described are those of annual species (herb

steppe, often quite unstable), *Salsola* communities (the dominance of which on grassland has been attributed to over-grazing but in the majority of instances it is considered as an example of seasonal dominance) and distinctive communities formed by species of *Atriplex*, *Bassia* and *Threlkeldia proceriflora* which furnish good forage, at least when young.

9. *Miscellaneous communities of the more arid regions.* These are classified into those dominated by a single species which is more or less shrubby and those of ephemeral species.

10. *Miscellaneous communities of the Dividing Range.* A peculiar type is developed on the upper rocky slopes and adjacent ranges which is briefly described.

Induced Communities.

11. *Artificial grasslands.* Clearing of timbered areas, especially on the usual sandy soils of the south-east, results in the production of a ground cover in which *Aristida* spp. dominate. With continued stocking *Bassia Birchii* tends to replace the grass. On the heavier soils in the south-east *Chloris divaricata* or *Sporobolus Caroli* is usually prominent. Subsequent change may involve the entrance of chenopods and heavy over-grazing produces dominance of the *Atriplex leptocarpa—Bassia—Threlkeldia* community. It has been reported that in the felling of *Acacia Cambagei* a wealth of herbage appears but does not persist.

13. *Communities of stock-routes and reserves.* In contrast to the deleterious effect of continued stocking an instance is cited in which a paddock on ashy downs, consistently heavily stocked with sheep for many years, carried a fine stand of mixed *Astrebla* spp. and other herbage, while an adjacent area, left idle for some years, contained sparse vegetation and consisted chiefly of young *Salsola* and *Euphorbia Stevenii*. A varied reaction to grazing seems to be connected with the nature of the soil and leeward or windward slopes. Plant communities are described which result from grazing regularly in excess of the carrying capacity. Unpalatable perennials become dominant and are associated with various short-lived annuals. Thus on sandy soils *Bassia Birchii* develops, together with *Aristida* spp., *Tragus biflorus* and *Perotis rara*. Extremes of environmental conditions operate on plant life chiefly on stock routes. Such routes on heavy soils are dominated by *Atriplex Muelleri*. (See also Francis and Everist, *Herb. Abstr.* 5. 219-20. 1935). Every gradation from grassland to claypan occurs on the routes and much depends on season and the amount of stock which passes.

14. *Communities of introduced species.* The most important species are *Parkinsonia aculeata* (introduced from the West Indies as a shade and fodder tree), *Xanthium pungens* and *X. spinosum* (among the worst pests of grazing districts, both are poisonous when young) and *Argemone mexicana* (avoided by stock). *Opuntia inermis* once formed dense communities but it is being exterminated by *Cactoblastis cactorum*.

In considering the status of the communities and their relationships, the following items are noted : (1) *Acacia harpophylla* is slowly extending its range, and both grassland and *Eucalyptus* forest have been invaded and replaced. (2) There is a tendency for *A. Cambagei* to invade grassland of the gravelly downs, but the reverse process is also in operation. (3) *Astrebla* sp. has replaced *Dichanthium sericeum* in large areas. (4) The relationship between chenopod communities and the grasslands is unstable. (5) It is concluded that the desert area has regressed and the dunes support an increasingly stable vegetation.

Almost throughout Queensland the vegetation is of an unstable nature and the changes oscillate. The term fluctuating climax is used to denote the condition in

which the major communities concerned may be designated complementary. Each complementary community exists under an environment probably controlled by rainfall, systems of stocking and possibly cyclic variations in the salt content of the soil. With these facts in mind it is possible to recognize the following formations in Western Queensland (on the basis of Clements, Carnegie Inst. Wash. Publ. 242. 1916) : open and closed forest formations, the acacia scrub, *Triodia* formation, grassland, channel country, swamp, shrub-steppe and desert. The publication contains a map showing the distribution of these formations and their major associations, and there are plates with forty illustrations.

SURVEY OF THE TUSSOCK-GRASSLANDS OF THE SOUTH ISLAND, NEW ZEALAND

[The following summary of the preliminary report of the above survey, written by V. D. Zotov, Botany Division, Plant Research Bureau, Department of Scientific and Industrial Research, is quoted from the New Zealand Journal of Science and Technology, December, 1938.]

THE tussock-grasslands of New Zealand are of the general steppe type, conforming to this in all essential characteristics. Those portions which do not quite conform are of strictly induced formation. Throughout the greater part of the country the soil is derived, directly or indirectly, either from greywacke or mica-schist. The characteristics of the climate distinguishing it from those ruling steppes elsewhere are the high velocities of the wind (north-west) and the low mean summer temperatures (about 16.5 C. at sea-level). Few records describing the vegetation at the time of colonization are available. However, these and the surviving relics of the past vegetation, together with consideration of the climate, make reconstruction of the vegetation possible. The causes of depletion—i.e., retrogressive succession—were observed, and their disastrous effects were foretold as early as 1865, but neither this nor a number of subsequent inquiries had any effect on their removal. As the first step in the present study of the problem, reconstruction of the past vegetation was attempted, resulting in the general classification of the grasslands into the *true steppe* and the *induced steppe* regions. The present associations are essentially induced, either directly or indirectly, through human agencies.

Fire is the primary cause of depletion, and pastoralists freely resorted to fire to encourage more palatable young growth. Together with heavy grazing, it was responsible for the elimination of various species, one by one, and finally for the more or less complete destruction of vegetation. Heavy infestation by rabbits added to the effects of overgrazing, but it must be observed that this infestation was possible largely through the depletion already in progress. The tall, unpalatable, xerophytic tussock is an important element in the New Zealand steppes, in that it affords other plants shelter from desiccating winds. Burning down tussocks necessarily weakens other plants ; this results in baring of the ground, and finally in the death of the finer species and of the tussock itself. In this manner much of the vegetation, by various stages of retrogressive succession, has changed from steppe to desert, and even from forest to desert.

The first measure for the regeneration and improvement of tussock country which is unsuitable for ploughing or irrigation is the removal of the causes of depletion. The next is the re-establishment of favourable climatic conditions under which more delicate palatable species would thrive. This involves protection of the ground from high wind—i.e., re-establishment of tussocks where these have disappeared. The third measure would be the sowing of those palatable species which are natural to the existing climatic conditions. This consideration severely limits the choice among aliens, but there are a number of indigenes that should do well under controlled grazing.

Soil erosion inevitably follows the depletion of vegetation. Gully erosion is conspicuous in Marlborough and Canterbury, and, although much less so in Otago, it is not any less extensive there. More important, however, is wind erosion, particularly in Otago, where most of the windward slopes are now more or less completely stripped of their soil. Numerous places in Canterbury are also severely affected by wind erosion. Of the several other types of erosion in progress, by far the most widespread and spectacular is that due to frequent frosts, resulting in the soil being buried under a layer of stony debris. Extensive tracts of hilly country, both in Canterbury and in Marlborough, are laid barren in this manner. (See also *Herb. Abstr.* 9. Abs. 503).

CLOVER AND MALARIA

[Reviewer: G. M. Roseveare]

Although the literature on the alleged connexion between the presence of leguminous plants and immunity to malaria has already been reviewed[1,4,5 8], and although scientific investigation of the hypothesis—small in amount, it is true—appears to disprove it, the main points of the discussion are briefly recapitulated here with a view to inviting information on any experiments which may have been made in different parts of the world.

F. d'Herelle originated the theory in 1924, in his book on "Immunity in natural infectious disease."[6]. After discussing and rejecting another possible reason for the relative freedom from malaria of large tracts of anopheline-infested country in the Argentine Republic, he came to the conclusion that an attenuation of virulence had taken place in the malarial parasites of the mosquitoes, such as was described by B. Grassi for Tuscany in 1922[11]. Unlike Grassi, who considered that this attenuation was perhaps due to the fact that the larvae had developed in pure and not brackish water, d'Herelle attributed it to the presence of a species of *Melilotus* growing wild and very profusely in the immune, but not in the malarial regions of the Argentine, and flowering during the critical period of malaria (beginning of summer to the end of autumn). He said: "The highly scented blossoms are continually frequented by insects of many kinds, and particularly by Anophelines, which feed upon the juice which, like that of all plants of the genus, contains a glucoside, coumarine.... May coumarine play a role in the insects comparable to that which quinine plays in man?" He then noted the coincidence of a disappearance of malaria from certain islands of Zealand and from the northern provinces of the Netherlands with the accidental introduction of *Melilotus* to those regions. A further defence of his theory appeared in 1932[7].

The next protagonist of the hypothesis was Sir William Willcocks, formerly Director General of Reservoir Studies, Egypt, who had for many years sought the reason for Egypt's relative immunity from malaria. His attention was drawn to d'Herelle's theory, which he adopted with enthusiasm, publishing his findings in an address presented to the Egyptian Institute in 1927, and in letters to the *Times*[17,18]. Finally T. Krysto, a Russian doctor, published in an American journal in 1930 observations dating from 1895, that is to say, long before d'Herelle's hypothesis was mooted[12]. He first observed in several different parts of the Caucasus that where lucerne grew in the vicinity of houses, their inhabitants were free of malaria, although the region was infested with *Anopheles* and people not in the vicinity of the lucerne had malaria. When marshes uninhabitable on account of malarial fever were drained and sown to lucerne, the fever began to diminish, although anophelines were still present. He made similar observations in Turkestan in 1912, and received a report from the Governments of Orel and Tambov on the complete disappearance of malaria coincident with the planting of a large acreage of red clover. In 1911 he visited the Argentine Republic, and observations made there in connexion with lucerne confirm those of d'Herelle in regard to *Melilotus*. Both in the Caucasus and in Argentina the disappearance of malaria was commonly attributed to drainage and clearing, but Krysto opined that, since anophelines were still present, they were "neutralized by the juice of the alfalfa, and could not spread malaria." When touring in the United States, also, Krysto made observations in the southern States which confirmed his belief. Unfortunately, the data and photographs he collected were lost in his flight from Russia during the Revolution.

The interest aroused among scientists was not great. In 1927 Sir Ronald Ross said, in a letter to *The Times*: "We cannot understand why the presence of clover should prevent *Anopheles* carrying malaria, and it is a pity that such statements should be made without sufficient proof."[14] A certain amount of study was, however devoted to the subject. In India, Bruce Mayne made tests in 1930 on the effects of coumarin (crystals obtained from a chemist) upon the life of the mosquito and the malaria parasite,[13] and found that there was substantially no lethal effect of coumarin solution, in the strengths used, on the parasites of malaria in the mosquitoes tested. It is interesting to note that although sixteen out of twenty specimens succumbed when exposed to the action of 1-1,000 coumarin solution, their parasites evidently were not affected. Larvae bred in coumarin-containing water, fed on coumarin as adults, and subsequently on infected birds, were returned to the coumarin vessel: the parasites developed normally, and eventually active, typical sporozoites appeared. In 1931 feeding tests were made by G. H. Bradley at the United States Bureau of Entomology's Laboratory, situated at Mound, Louisiana.[3] The district is rich in legumes, both wild and cultivated, *Trifolium repens* being especially common. Malaria is also very common. Known numbers of *Anopheles quadrimaculatus* Say were confined in cages containing sprigs of legumes in flower (three cages), raisins (one cage) and wet cotton (one cage). The legumes used were five different *Melilotus* spp., *Trifolium alexandrinum* and *Trigonella foenum-graecum*, and the mosquitoes were individuals which appeared to be freshly emerged and showed no evidence of having had a blood meal. Observations (tabulated) appear to indicate that mosquitoes do not feed to any extent on either the blooms or foliage of legumes; that legumes are not attractive to mosquitoes; and that when confined in cages with legumes, mosquitoes obtain little, if any, sustenance from the plants. Thus even if it is admitted that coumarin can disinfect malaria-infected mosquitoes, it would appear that, in the case of *Anopheles quadrimaculatus* Say, at all events, there is little likelihood of its ever obtaining this substance by feeding on legumes. In 1930 Stratman-Thomas, under the auspices of the Mississippi State

Board of Health and with the support of the International Health Division of the Rockefeller Foundation, made a survey of the population of a part of the Mississippi delta.[16] The district in question was once a notoriously bad malarial region, but it had been distinguished for the last fifteen years for an almost uninterrupted decline in mortality from this cause. The decline coincided with the introduction of lucerne, grown on land which had been rendered unsuitable for cotton by the advent of the boll weevil. Stratman-Thomas examined 1,858 people, and found the malaria index of the total population to be 3 per cent; in areas near standing water, however, it was 9.45 per cent. No apparent correlation could be found between the distance of residence from lucerne fields and the incidence of malaria, but a positive correlation was established between the distance of residence from standing water and the incidence of malaria. " People living adjacent both to standing water and alfalfa are not protected from malaria by alfalfa. . . . . Wherever a decline in malaria incidence coincides with the planting of alfalfa this decline is due directly to the proper drainage necessary . . . . for the cultivation of alfalfa." Barber and Forbrich,[2] surveying for malaria the irrigated regions of New Mexico, under the auspices of the Rockefeller Foundation, remarked in their report that " Alfalfa and sweet clover are common in New Mexico, but apparently offer no hindrance to the spread of malaria."

D'Herelle wrote in reply to Mayne and to Stratman-Thomas in 1932.[7] " The experiments of Mayne, who has shown that coumarin when ingested by the mosquito has no effect on gametogenesis or on the developing öocytes, do not contradict my hypothesis because I have not assumed that coumarin (or any other substance contained in the honey of *Melilotus* flowers) was capable of killing the malarial parasites, but was probably responsible for the attenuation of its virulence observed everywhere in relation to the phenomenon of Anophelism without malaria." D'Herelle considered that it would have been preferable to test the effect of *Melilotus* honey rather than synthetic coumarin. Further, he considered that Stratman-Thomas' method of survey, wherein the latter selected fields of lucerne not more than one to three years old, would be valuable only in the case of an acute disease, whereas malaria is a type of chronic disease *par excellence*. As Stratman-Thomas wrote, " the infections encountered were probably largely chronic and attributable to the malaria season of 1929 or to the malaria seasons of prior years." The attenuation process, however, is a gradual one. A general malarial index is considered by d'Herelle to be of no value in proving the case. Rather there should be taken " the malarial index of the children born near the clover fields *since the first flowering of the crop*," and this index should be compared with the malarial index of the rest of the dwellers, two similar indexes being taken at a distance from the clover as control. Such indexes should take into account only the presence of hematozoa in the blood, to the exclusion of " positive histories." In connexion with the argument that not the lucerne itself, but only the drainage necessary for lucerne cultivation produces a decline in the incidence of malaria, d'Herelle notes that for more than a century cotton and Indian corn (*Zea Mays*) have been grown in the Mississippi delta, both crops requiring drainage, but the drainage of fields for cotton and corn did not reduce the incidence of malaria.

Sir William Willcocks' replies to criticisms made by F. C. Willcocks and by Kirkpatrick, both entomologists, are given in an appendix to his pamphlet.[17]

Of the reviewers, Covell[4] said : " There is no definite proof that clover has any effect on the incidence of malaria. . . . . The planting of certain trees and plants, however, has a good effect by drying up water and reducing the level of the subsoil water."

H. Ziemann, of the Pathological Museum, University of Berlin, was interested

in d'Herelle's theory, and, with the aid of some botanists, compiled a list of plants containing coumarin.[19] Soesilo, from the Dutch Indies, compiled a complementary list.[15]

Of actual experiments beyond those reported in the literature, none is known to the Bureau except an attempt made to test the possibilities of growing clover in the Colony of the Gambia, West Africa, with direct reference to d'Herelle's theory. Three species of clover were obtained from the United States Department of Agriculture in 1928-29 and sown in nursery beds. Good germination was obtained, and *Melilotus officinalis* and *M. indica* made good growth, the former flowering profusely just at the period when mosquitoes begin to be troublesome. The clovers were, however, a complete failure in the following rains.[9,10]

The Bureau is indebted to the Librarian of the London School of Hygiene and Tropical Medicine, Mr. Cyril C. Barnard, for several references.

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PHASIC DEVELOPMENT OF PLANTS (2)

A review recently prepared by the staff of the Imperial Bureau of Pastures and Forage Crops, and published under the authorship of R. O. Whyte, *Biol. Rev.* 14. 51-87. 1939, is being summarized in serial form in the four issues of *Herbage Reviews* for 1939. The first discussion appeared in the March issue, pp. 27-32.

Plant Development and Habitat Factors

In the newer conception the developmental period, including the vegetative period, is thought to consist of a sequence of ecologo-physiological phases, the length of each, or rapidity at which a phase is completed, varying for a given plant independently with the environment. The effect of an environmental factor or factors on the developmental period must, therefore, be studied with discrimination at each of the phases, that is, with reference to their effect on each phase independently.

At any time in its life, a plant is subject to the continuous, but fluctuating complex action of temperature, light and other direct and indirect environmental factors, yet not all the component factors necessarily affect the progress of every phase. For instance, in Avakijan's experiments (p. 71 of the review) with wheat, the vernalized and unvernalized plants failed to head in short photoperiods, but in long photoperiods the vernalized plants headed rapidly, whereas the unvernalized persisted in maintaining their vegetative growth. Neither light nor darkness, therefore, had any effect on the state of the plants which had not completed the first phase (the phase of vernalization), and yet the same factors had a potent effect on the plants which had completed that phase. Virtually the same conclusion may be made as regards the effect of darkness (short day) from Razumov's experiments (p. 58), and numerous other experiments quoted elsewhere in the review. The same factor, therefore, can be effective or potent for one phase, and ineffective or impotent for another phase of the same plants. Co-ordinating the potency of factors with the physiological state of the plant in its advance towards reproduction, Lysenko discriminated from among the environmental components the potent factors which affect the progress of the phase at issue.

Moreover, the very trend of the action of the effective factors may become reversed with advance in development; in Meljnik's experiments with wheat (p. 65) darkness retarded earing of vernalized plants, but only if those plants had not previously received not less than 20 long days. Again, in Lysenko's experiments with different thermophytes (p. 66) long summer photoperiods did not have an adverse effect on time of flowering of plants from seeds vernalized in darkness, although they delayed flowering of plants from seeds vernalized in short photoperiods, and still more from those vernalized in long photoperiods.

Furthermore, as is shown in the experiments on the stimulation of vernalization by different chemical agents (p. 57), not all the affecting factors are necessarily those without which the phase at issue cannot proceed with more or less facility.

Lysenko selected those factors which are biologically indispensable for the progress of a phase and dealt almost exclusively with them. Such a division of environmental factors does not in any way conflict with the ecological division into direct and indirect factors; on the contrary, this division details and co-ordinates their potency with the developmental state of the plant, so that we can, in fact, justly speak of the habitat of the developmental phase.

Finally the experimental evidence quoted on pp. 59-61, 66-7, 69-70 and elsewhere would suggest that the progress of a phase depends not upon any single factor, no matter how potent it may appear, but upon the entire complex of interconnected

and mutually affecting habitat factors. A change in one of the components would affect the efficacy of the entire complex ; that is, the law of limiting factors is retained, although admittedly in a form different from that introduced by Blackman.

The ecologo-physiological phases occur, as already stated, in a strict rotation and a phase must be fully completed before the onset of the subsequent phase is at all possible ; in the experiments described on p. 72, only those plants which were vernalized for not less than a definite number of days eared in long day, while the plants vernalized for any shorter period failed to respond to long day until they were additionally vernalized at lower temperatures for the number of days they lacked previously.

Much experimental evidence is available (see pp. 13, 16 and 19-20) which would convey the idea that the completion of a phase does not affect the rapidity at which the subsequent phase is completed ; that is, the ecologo-physiological phases, although being " qualitative" continuations of the preceding phases, are independent of each other in their relation to the environment. The progress of a phase will be the more rapid the nearer to the optimum range are the habitat factors during that physiological period of the plant's life.

Since, with advancing development, plants change their requirements and consequently their response to environmental factors, it is of the utmost importance in ecological and physiological studies to account not merely for the factors acting upon the plants, but also for the physiological state (developmental phase) at which the plants became exposed to their action. To illustrate this we shall refer to one of many experiments found in the literature.

In the experiment with winter and spring cereals (Garner and Allard, 1923) grown at " the temperature usually running 55 to 60°F. at night and 70 to 80°F. during the day," winter barley headed at practically the same time in seasonal photoperiods (148 days) and under additional electric light during the night (149 days), and much later than spring barley which headed in 109 and 65 days respectively. At a glance it would appear evident "that a fundamental distinction between the winter and spring types as such rests on the rapidity with which the latter respond to the increasing day length of spring," unless a closer view is taken of the reactions of the plants during the experimental period.

In the first place, in early development (the phase of vernalization) when spring and winter cereals are insensitive to day length as far as their advance in development is concerned, but are conspicuously distinct in their sensitiveness to temperature, the relatively high temperature would delay the onset of the light-sensitive phase more in winter than in spring types ; secondly, the progress of the light-sensitive phase at temperatures lower than then required would be more seriously handicapped in winter than in spring barley ; and thirdly, the length of day increased during the experimental period from 9—10 hours in December and January to 11—12 hours in March, and to 12.5—13.5 hours in April, while the plants being tested may also be distinct in their respective critical photoperiod. Allowing for these neglected aspects which find admirable illustration in the experiments described on pp. 63, 66-7 and 69 of the review, one may gather to what extent the conclusions quoted are actually warranted.

Developmental Phases

The developmental period must, therefore, in the light of recent investigations be considered as a sequence of at least ecologically distinct phases, the investigation of which would appear to have become an urgent ecological study. A good deal has indeed been done in this direction, but unfortunately the results of these investigations are very incompletely known. Nevertheless, from what is known of these studies, one obtains the impression that developmental phases are being studied very un-

systematically and, what is most important, without adequate accuracy and not infrequently on too broad and general lines to provide anything other than a very vague and preliminary insight ; consequently, many of the conclusions reached are subject to serious objections and require careful revision.

Nevertheless, with all these handicaps, the results hitherto obtained have proved to be of decisive importance and have in fact changed many apparently firmly established conceptions. It is, indeed, significant that the newer conceptions do not infringe the earlier experimental evidence as such ; on the contrary they seem to give them a fuller, if not an altogether new interpretation, and not infrequently reconcile long-standing conflicts.

The Thermo-Phase

The phase of vernalization, or the first phase which, for reasons stated below, we shall call the thermo-phase has been established in all the plants studied hitherto, but with a varying degree of accuracy and detail as regards the factors affecting its initiation and progress.

" Of the three factors described as biologically indispensable," only temperature would appear to concern directly the rapidity of those physiological readjustments which constitute the thermo-phase. The other two factors, namely, adequate moisture and free access to air to ensure normal respiration appear to be far less specific to this particular phase, and there are grounds for believing that they affect the thermo-phase only indirectly, namely, by maintaining the tissues in a certain state of physiological activity, which is equally indispensable for this as for any other phase and growth. Day length and nutrition also appear as accessory indirect factors, but their participation may be almost entirely ruled out in vernalization of seeds without producing any adverse effects.

It is different with temperature ; two critical limits seem to exist on each side of the optimum range. On the other hand, it would appear from what is said about regulation of temperature during vernalization (p. 59) that temperature at the same time also affects the state of physiological activity of the tissues and it is in this action that temperature seems to be correlated with the two other indispensable factors of vernalization of the thermo-phase.

The optimum range of temperatures which ensure the most rapid progress of the thermo-phase was found to vary as widely with varieties and biotypes between as within species ; in cereals from 0 — 3°C. to 8 — 15°C. or even higher, in tomatoes from 8 — 12°C. to 22 — 25°C., in millet, soybeans and cotton from 20 to 35°C., etc. The deviation of habitat temperature on either side of the optimum range would adversely affect the thermo-phase ; for instance, in Lysenko's experiments with winter wheat (p. 59) the thermo-phase was completed in 40 days at 0-2°C., in 100-150 days at 15-20°C., and was inhibited altogether at temperatures above and below the critical limits.

Under the optimum range of temperatures, the length or rapidity of the thermo-phase was also found to vary ; on the whole, it would appear that the higher is the optimum range, the shorter is the phase. For instance, Dolgušin sub-divided wheats into five groups in respect of the optimum temperature and the time required at those temperatures to vernalize the thermo-phase.

Group	Temperature	Time required in days
First	8-15°C.	5- 8
Second	3- 6°C.	10-15
Third	2- 5°C.	20-25
Fourth	1- 4°C.	30-35
Fifth	0- 3°C.	30-45

Again, Lysenko (1936) recommended (for vernalization of seed) for winter wheats and barley, 0-2°C. for 35-40 days; for late hard wheats, spring barley and oats, 2-5°C. for 10-14 days; for early hard wheats, soft spring wheats, 10-15°C. for 5-7 days.

The meaning and significance of this rather unexpected and interesting regularity we shall endeavour to discuss later; it now suffices to say that in the light of these and other experimental data quoted in the review, it appears that there are no specific "winter" or "spring" groups whatever; the difference between them is not in kind but in quantity, which does not exceed the varietal range. Moreover, any variety may behave as "spring" or "winter" according to the place and time of sowing, that is, whether or not the thermo-phase can be initiated and progress under a particular temperature condition following sowing. Investigations of the thermo-phase have thus resolved a long disputed problem as to the ecological and physiological differences between spring and winter types. Unfortunately, this aspect has not been given much attention in the review.

In connexion with the thermo-phase another aspect requires particular mention namely, that under alternation of temperature, for instance, night and day temperatures, there is something like a critical thermo-period, that is, a minimum daily period of continuous temperature favouring the initiation and progress of the thermo-phase or, in other words, the tolerance of plants at the thermo-phase to the duration of temperatures above the critical limit, alternating with vernalizing temperatures. This critical thermo-period will of course vary both in terms and duration according to the biotypes and must not be overlooked in ecological studies, where more accurate recording of temperatures must be adopted than the daily means.

The Light-Sensitive Period

We have shown that day length does not at least directly affect the progress of the thermo-phase as such; daylight is, however, necessary for normal photosynthesis and other functions maintaining the tissues in a physiological state at which the progress of the thermo-phase is possible. Until recently there was a considerable divergence of opinion on this point; it was repeatedly pointed out by some investigators that winter and spring types, for instance, differ in their sensitiveness to prolongation of daylight, that is, in the rapidity of their response to long photoperiods. On the other hand, Wanser pointed out that winter types as distinct from spring types seem to have two distinct critical photoperiods, the short photoperiod for initiation of culms and a longer one for heading. Lebedinceva and McKinney and Sando reached the same conclusion, the latter describing winter cereals as *short-day*——→*long-day*, as far as photoperiodical response is concerned. These claims have indeed been preceded and succeeded by others, but no definite conclusions could be formed, as the progress of the thermo-phase was not recorded; conclusions based upon time of earing or even jointing are unconvincing, as the thermo-phase is not the only possible handicap preventing or delaying earing.

With more detailed investigations, as made at the Agricultural Institute, Kharkov (1936-1938), a distinct requirement for darkness was indeed established in wheats, not for completion of the thermo-phase, but for completion of a phase "transitional" between the thermo-phase and the photo-phase (in Lysenko's terminology); at that developmental phase all the types of wheat proved to require high temperature in contrast to the preceding thermo-phase, and darkness in contrast to the subsequent photo-phase. The length of the "transitional" dark phase varied with varieties from 8-18 days. It can be safely assumed that a similar phase will be found in other plants, particularly in those which are not so typically "long-day" as spring wheats. Little is yet known of this phase, but its discovery, the significance of which will be discussed later, is of the utmost importance.

As regards the photo-phase as announced by Lysenko and his immediate associates, it was until recently regarded as a new interpretation and a "rather unexpected approach" to photoperiodism as defined by Garner and Allard.

The completion of the photo-phase is thought to be intimately connected with a specific action of light or darkness in association with some other environmental factors, among which temperature is, perhaps, most prominent. According to Lysenko, for the completion of this phase certain plants (long-day plants) require continuous daylight and can tolerate alternation of light and darkness, only if the dark period is not in excess of a critical length ; other plants (short-day plants) require continuous darkness and can tolerate photoperiods only if they do not exceed a certain critical length. Therefore, the response of plants to definite photoperiods, as established by Garner and Allard, and the significance of photoperiods received quite a different interpretation. Moreover, a definite requirement for light or darkness, and hence a tolerance of photoperiods are characteristic of plants, not throughout their lifetime, but only during a certain interval in their life, after which their relation to light and darkness is changed ; long days will not prevent the further development of short-day plants and short days will not retard development of long-day plants.

Consequently, the photoperiodic classification of plants does not hold true throughout their lifetime, but only (and then in a more accentuated form) during that period called by Lysenko the photo-phase, but this point will be discussed more fully later.

Temperature plays by no means a less prominent part in the rapidity with which the photo-phase is completed and has been found to be closely related to the effect of light and darkness. In its main outlines, some interesting regularities in this respect have been disclosed which may suggest that high sensitiveness to light is associated with requirements for higher temperature ; for instance, winter forms proved to require higher temperatures than spring forms, or at least the latter were more tolerant of lower temperatures than the former. In millet and possibly in some other short-day thermophytes, somewhat lower temperatures are required at the photo-phase than at the thermo-phase, or at least a fall of temperature seemed to have a less deleterious effect on the photo-phase than the thermo-phase. Undoubtedly the critical photoperiods (in Lysenko's terminology), the optimum temperature and the length of the photo-phase vary widely (and somewhat confusingly) with biotypes and species, but this aspect has not yet been studied sufficiently to warrant any definite conclusions. Other environmental factors, such as the conditions for photosynthesis, nutrition, moisture, etc. might affect directly or indirectly the progress of the photo-phase, but environmental studies of this phase have so far been too general. In early experiments with short-day thermophytes successful attempts were made to vernalize this phase, that is, to induce embryos (slowly growing seeds) to pass it before sowing, but this line of research seemed to have some drawbacks, at least technical, and has apparently been abandoned.

The investigations of the thermo-phase and the light-sensitive period have introduced many new conceptions, but not all of them can justly be described as "an unexpected approach to photoperiodism," as long before the announcement of the new principles and soon after the announcement of photoperiodism the ever-increasing experimental evidence indicated that photoperiodism was at fault. That plants do not require the same photoperiods throughout their life, but change in their relation to light and darkness with their advance in development had already been anticipated as a result of the study of "photoperiodic after-effect" or "photoperiodic induction." But again, it was only in the light of phasic development that these anticipations acquired a definite shape and were substantiated, although, as will be shown later, the more recent conception of Lysenko was not free from its own faults. Yet, despite

some flaws and incompleteness in the new outlook, it may nevertheless be safely said that the chapter of photoperiodism in the history of science has concluded and that ewer investigations of the light-sensitive period in the life of plants have initiated an new chapter on the true relationship, not apparent as in photoperiodism, of plants to relative durations of light and darkness. Nevertheless there has been an advance, but not a revolution in our knowledge.

Subsequent Developmental Phases

Upon the completion of the photo-phase plants enter into a new relationship with the environment and with daily photoperiods in particular ; this may safely be deduced from the announcement of the discovery of the "third phase" in wheats, which can be completed in much shorter photoperiods than the preceding photo-phase. The third phase has been studied very inadequately and much of the new relationship of plants to day-length has remained obscure. Even if it were assumed that, with the completion of the photo-phase, only the critical photoperiod is changed, "it remains obscure, however, why plants in a 6-hr. day produced normal pollen and seed as rapidly as in a longer day." Whyte assumed that it is likely that in this phase, closely associated with gametogenesis, two consecutive phases were telescoped, one requiring darkness and the other light, experimental evidence in support of this assumption being quoted in the addendum to the review. Actually, in the experiments quoted, three months' shading had a less deleterious effect on the vegetative period than two months' shading ; in fact, in some cases longer shading induced earlier earing. The experiments were, however, arranged upon such a wide basis that they are hardly reliable and at best the results would seem to emphasize that the conclusions in the review deserve close attention. If this supposition is proved to be correct, the number of developmental phases usually passed through by wheat and other cereals after sowing amounts to five, that is, exactly the number predicted by Lysenko. It can be assumed that, with the maturation of gametes, that is, with the end of the second light-sensitive period, the developmental period of the plant ends and with fertilization the beginnings of the developmental period of the daughter plants are laid down and the mother plants begin to die.

These are in their main outlines the general characteristics of the developmental phases. It is obvious that these studies are still of a preliminary nature, but even in their incomplete form they do provide a basis for the formation of some theoretically and practically important conclusions and conceptions, which can be adopted for further investigation.—M.A.O.

THE TEMPORARY LEY

[Reviewer: R. O. WHYTE]

THE Welsh Plant Breeding Station has published the first Bulletin to appear since Series H. No. 14 in June, 1936. The new work is entitled "The temporary ley" (Series H. No. 15, pp. 150. Aberystwyth, 1939), and contains four contributions on this subject, which is of particular interest in connexion with the increased ploughing of grassland in Great Britain, and the introduction of rotations into the agriculture of the United States for the purpose of soil conservation.

Wm. Davies describes an experiment dealing with the use of Station-bred and commercial strains of perennial ryegrass (*Lolium perenne*), cocksfoot (*Dactylis glomerata*), and timothy (*Phleum pratense*) in connexion with the production of high-class temporary leys on relatively poor soils. Under the conditions of the trial, cocksfoot was the heaviest yielding grass over the first three harvest years, perennial ryegrass second, and timothy third (ratios 117 : 100 : 61). In the first harvest year, particularly in the hay plots, the commercial seeds were superior in yield to the Station-bred lots, but by the third harvest year the latter were decidedly superior both with regard to gross yield and even more so with regard to yield of sown grasses. Timothy does not establish itself properly in competition with either of the other species, but sown as the major grass with red and white clover, the Station-bred pasture timothy makes an attractive high-yielding sward. Timothy must, however, be regarded as a special-purpose grass for use in mixtures in which it is the main constituent.

During the seeding and first harvest years perennial ryegrass is highly aggressive towards both cocksfoot and timothy. Subsequently Station-bred leafy cocksfoot equals Station-bred leafy ryegrass in this respect. Station-bred leafy timothy does not exhibit any aggressiveness in competition with these two other grasses.

The commercial strains of these grasses fail to persist under either hay or pasture conditions and rapidly disappear after the first two years.

Timothy and perennial ryegrass were more palatable than cocksfoot under open grazing conditions, it being difficult to keep the leafy Station-bred strain of cocksfoot properly grazed, especially during the third harvest year.

Red clover (*Trifolium pratense*, Montgomery strain) caused a marked increase in the yield of plots in which it was included. It had a direct beneficial influence upon the grasses, particularly in the first and second harvest years. Basic slag applied a month after seeding increased the gross yields, but more particularly in the first harvest year. There has been a direct effect of the phosphate stimulating the grasses before having any apparent influence upon the legumes. The ultra-simple mixture of one grass with red and white clover has been superior in yield to a mixture consisting of five grasses, plus the two clovers. Perennial ryegrass tends to suppress the clovers chiefly in the first year. In the second year white clover is suppressed more severely by cocksfoot than by ryegrass. Pasture types of both cocksfoot and ryegrass are more aggressive than the commercial strains, except during the seeding year.

W. E. J. Milton discusses two experiments.

(1) On the seeding and persistency of strains of species grown in mixtures under practical conditions, which disclosed differences in yield, response to manures and tiller production. Mixtures which contained indigenous strains or a blend of indigenous and commercial gave better hay yields than those in which indigenous strains were in the minority, or lacking. A greater response in yield to phosphatic manuring was given by the indigenous and semi-indigenous mixtures. When potash was added to the phosphate and nitrogen, yields were increased.

(2) The second experiment conducted on the blending of species in simple mixtures showed that a mixture of two grasses could equal in pasture yield mixtures containing more species, but that the usual combination of top and bottom grasses with red and white clovers gave slightly higher yields.

Ll. I. Jones gives an account of the reaction of swards differing markedly in their botanical composition to a number of widely differing systems of management. This data collected and submitted show that the system of management to which a sward is subjected determines :

(*a*) the total yield of herbage,
(*b*) the contribution of each species,
(*c*) the type of plant, even within a species, which predominates in the sward,

Continuous defoliation by the grazing animal results in a sward composed of a large number of small tillers, whereas occasional defoliation, and especially the absence of any defoliation, lead to a sward composed of a smaller number of big tillers. Although this is partly brought about by the direct effect of the grazing animal in reducing the size of plant by constant defoliation, it is chiefly due to a change in the botanical composition ; plants normally bearing a larger number of small tillers being more abundant on the hard grazed plots than on the lightly grazed and ungrazed areas. This is true both for different species and for different strains or growth forms within a species. These multi-tillered plants are usually more prostrate in growth than those bearing fewer tillers, each of which is larger in size. Thus there is less danger of the former type of plant being harmed by hard grazing, whereas the latter, with its more erect growth, is more likely to be harmed by the grazing animals, but is better suited than the former for surviving among the tall growth. This shows that the abundance of any plant in a sward depends on

(*a*) its reaction to the grazing animal, some species being far more tolerant of grazing than others ;
(*b*) the reaction of the other species present and their effect, if any, on the species concerned. Some species do not thrive when subjected to grazing, but become very aggressive and dominant in the absence of the grazing animal.

Thus the botanical composition of a sward depends on the reaction of the various plants forming it to the conditions of management, and also on their ability to withstand the aggressiveness of the other components of the sward under those conditions.

To conclude this Bulletin, the Director of the Station, Sir R. George Stapledon, discusses the practical implications and tendencies of the results set forth in the above papers, in relation to evidence which is accumulating from other experiments in progress or derived from experiments conducted previously. The question of the establishment and maintenance of temporary leys is discussed with the heads of (1) the influence of defoliation and animal residues on productivity and persistency ; (2) basic slag, grass and clover ; (3) the different strains of the grasses ; (4) the importance of edible herbs ; and (5) the seeds mixture. For complete bibliographical details see *Herb. Abstr.* 9. Abs. Nos. 537, 875, 876, 910.

EROSION AND OTHER SURVEYS IN EAST AFRICA

[Reviewer : R. O. Whyte]

As a result of recent surveys of soil erosion, land utilization, and water supplies in East Africa, data are now accumulating which will be of great value in formulating

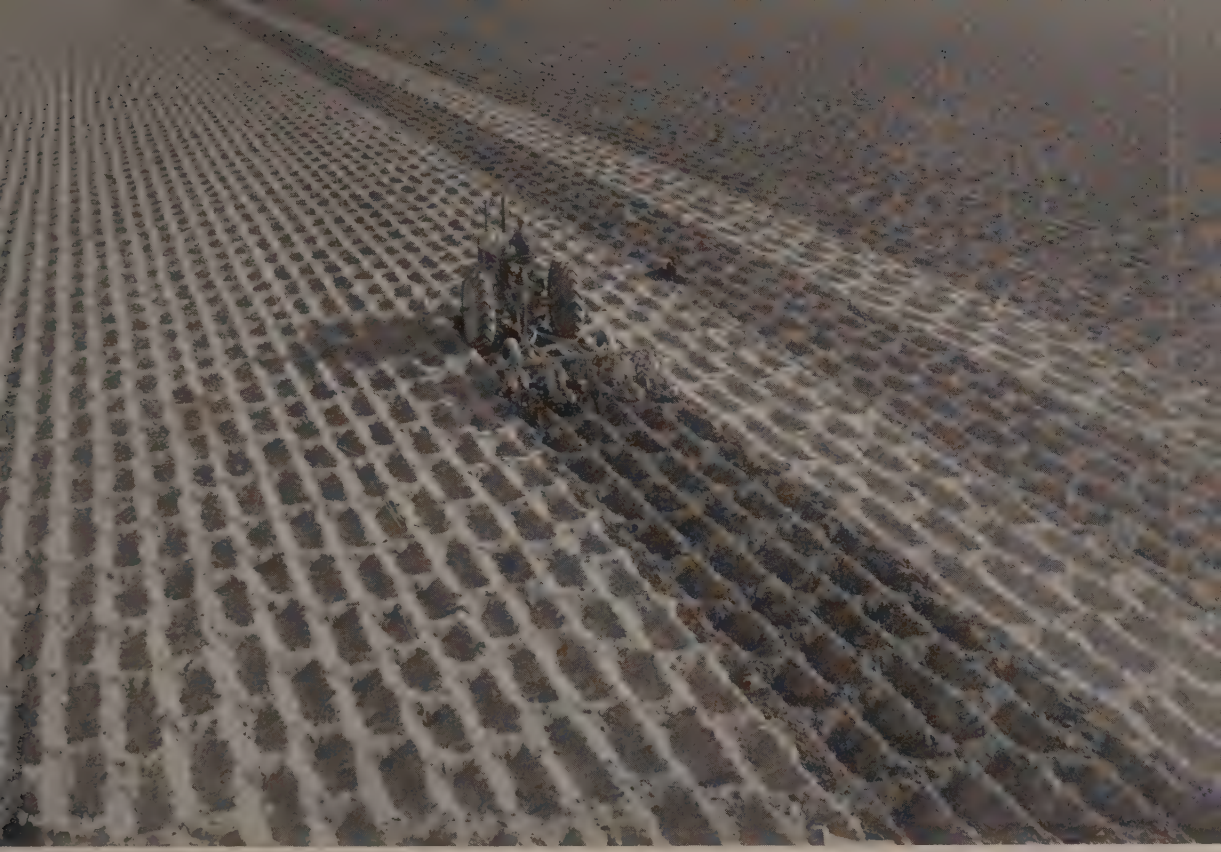
soil conservation programmes and for agricultural planning in general. An account of the position in Tanganyika has already appeared, (*Herb. Abstr.* 8. Abs. 1483), and an extensive survey has been made of the reserves in Kenya, by Colin Maher, now appointed officer-in-charge of the Soil Conservation Service in the Kenya Department of Agriculture. Mimeographed copies of the Reports of the latter surveys have been prepared, but are apparently not intended for general circulation.

Other Reports recently published are "Soil erosion and water supplies in Uganda," by E. J. Wayland, N. V. Brasnett and others (Entebbe, 1938, pp. 91. pls. maps; "Report of the agricultural survey of the five most northerly districts of Nyasaland" (Zomba, 1938. pp. 103); and "Report on a visit to Kenya" by I. B. Pole Evans (Nairobi, 1939. pp. 36. pls. map). This last-mentioned report by the Chief of the Division of Plant Industry, Department of Agriculture and Forestry, Union of South Africa will be reviewed in the September issue of *Herb. Rev.* Dr. Pole Evans states that "the great problems of erosion, the success of the animal industry, the fate of the native population, and the life of Kenya, depend entirely on the advancement of pasture research. Unless pasture research, therefore, is given the place it should command in the administration of a pastoral country, no progress can possibly be made . . . . . a new outlook with regard to grassland pasture is vitally necessary. . . . . Pasture research can only progress under those who realize its importance and sympathise with its aims. . . . . What is urgently needed is an active and powerful Department of Pastoral Research—a department which will not only save the semi-arid and arid regions, but will also in course of time build up pastoral industries on the magnificent natural pastures of Kenya's moister regions. . . . . Kenya's future depends upon the application of pastoral science."

The Uganda report states that that country is more fortunate than the southern Sudan, Kenya, or Tanganyika Territory, the destructive processes of soil erosion and desiccation not having proceeded so far. A large proportion of the country carries a good vegetative cover under a well-distributed rainfall; the soil developed under these conditions is of good structure and not easily eroded. The great extension of cultivation to provide economic crops has, however, in recent years resulted in considerable deterioration even on soils most resistant to erosion, while sandy erodible soils have suffered most severely. Uganda is threatened by the advance of soil-drying conditions from those countries to the north, the east and the south, but as active combative measures are being taken or are pending in these neighbouring territories, the authors of the Uganda Report confine themselves to a detailed presentation of the position in Uganda, and make a series of recommendations for improving the situation in the various regions. Particular attention is devoted to Karamoja, which occupies a key position as far as Uganda is concerned.

The following "recommendations in general" are quoted from the Report.

1. Survey as a preliminary to demarcation of certain lands to be declared Crown Forests.
2. Demarcation on the ground and declaration of Crown Forests.
3. Experimental planting of certain chosen plant species for soil cover for various areas in the Protectorate.
4. Study of soils in relation to deterioration and erosion.
5. Experimental construction for above surface water supplies.
6. Establishment of central line of bored wells in Karamoja towards which people moved from protected areas will migrate.
7. Completion of the wells before the end of 1937, and survey for "sand-syphon" reservoirs. (The drilling programme for Karamoja has been completed and the survey for sand-syphon reservoirs is in progress.)



Basin listing in Colorado with the Peacock basin lister, which can deal with up to 40 acres per day. Any collected water is retained in the soil instead of running to waste, and the yields of wheat per acre are greatly increased.

[Photo by courtesy of Farmers' Weekly, London.]

To face p. 10

8. Construction of an experimental "sand-syphon" reservoir, if and when a suitable site is found.
9. Reduction of the livestock population in Karamoja.
10. Planting of gulley heads, etc. in the dry parts of Ankole.
11. Planting blocks of economic timbers in the Tree Savanna areas.
12. Protection of blackwood stands in West Nile.
13. Control of grazing where desirable.
14. Control of grass fires.
15. Control of mountain forests where desirable.
16. Investigation and experimentation with regard to water supplies in Ankole and West Nile, etc.
17. The usual anti-erosion measures such as gulley-bunding, etc.
18. Study of annular rings of trees in Karamoja, etc., in order to obtain climatic information if possible.
19. (A matter not dealt with in this report). The introduction of a suitable form of Land Tenure so that native owners may take a permanent interest in their lands, and may thus respond to anti-erosion and water conservation propaganda.

The Nyasaland survey of the five northern districts was carried out to investigate as completely as possible the distribution of various types of soil, the variation in the climate and vegetation of the chief agricultural divisions, the production and methods of cultivation of food-crops and the possibilities of extending further the production of economic crops. Included in the agricultural divisions which have been recognized or in broken country separating these main divisions are large areas which, owing to the great variation in rainfall and temperature over a short distance, the general steep slopes, the prevalent low fertility and poor vegetative cover, can take no part for some considerable time in assisting economic progress. It is considered that at least one-third of northern Nyasaland is covered by such dividing areas which do not fit into any recognized climatic or soil zone. If to this is added the high altitude grassland areas suitable only for grazing, it is found that two-thirds of northern Nyasaland can take no part for some time in agricultural development.

"It is regretted that the results of this survey should present such a drear picture of the 'dead' north but it shows at any rate that there is a vast field of work and that those who are responsible for the well-being of the native population should allow no time to be lost in framing a policy and programme of activities on the part of the departments concerned which will at least arrest the present rapid denudation and soil degradation."

A review of the position in regard to soil conservation in East Africa is further provided by a mimeographed publication from the Colonial Office, "A review of the position in regard to soil conservation in the Colonial Empire in 1937." London, 1939, pp. 72, which contains reports on the position in both the East and West African Dependencies.

Another comprehensive review of the problems to be faced in East Africa is provided by R.N.T.-W. Fiennes (Uganda Journal, 6. 137-47. 1939). This author discusses such varied topics as the climate of the East African tropical belt, the relation of forests to rainfall, the relation of rainfall to vegetation in general, the conservation efficiency of various types of vegetation, factors which adversely affect the plant cover, overstocking and erosion, the place of stock in land reclamation, grass burning, and modification of native methods of stock husbandry. The conclusion is that a planned agriculture is essential, and that by tactful handling this could be carried through with the willing co-operation of the Natives.

SCANDINAVIAN LITERATURE

MEASURES CALCULATED TO ENSURE A SATISFACTORY PASTURE YIELD UNDER SEVERE CLIMATIC CONDITIONS

[Reviewer: R. PETER JONES]

A paper by B. Wallin read at the Sixth Congress of the Association of Scandinavian Agricultural Research Workers at Uppsala, Sweden, in July, 1938; and published in *Svenska Betes- och Vallföreningens Årsskrift.* **20.** 218-227. 1938.

ONE of the difficulties of Norrland agriculture is that the domestic animals have to be stall-fed for such a considerable time during the year. The growing period in the North Bothnia littoral is 140 to 150 days while in the Uppsala district it is 210 days and in the province of Malmöhus 250 days. The mean temperature for the same regions is also very different, approximately +2°, +5° and +7° respectively. It is, therefore, of the greatest importance that the short summer should be utilized as intensively as possible by Norrland farmers.

To achieve a long grazing period, pastures in districts with severe climatic conditions should preferably lie on healthy mineral soils. Humus soils also are very suitable for pasture fields. Pasture on such soils is to be preferred to hay from them. After the earlier pasture on mineral soils has been utilized, it is probable that the herbage on humus soils will be in a sufficiently advanced stage of growth for continued grazing.

Some examples may be cited of the yields which can be achieved on pasture in good cultivation in Norrland, *inter alia* from the cultivation trials of the Swedish Grassland Association, averages for the years 1933 to 1936.

Nordvik, approximately 120 grazing days.
Average for the whole experiment area 1.41 ha., in 4 folds, 2,945 food units per ha.
„ „ deep cultivation area 0.71 ha., in 2 folds, 3,513 f.u. per ha.

Bratiby, approximately 110 grazing days.
Average for the whole experiment area 1.58 ha., in 6 folds, 1,978 f.u. per ha.
„ „ deep cultivation area 0.81 ha., in 3 folds, 2,244 f.u. per ha.

Sörbyn (province of West Bothnia.)
Average for 2 years, 4.93 ha. pasture ley on arable in 3 folds, 2,390 f.u. per ha.

For the province of North Bothnia, Ulander has estimated the yield of individual pastures to be about 4,000 food units per ha.

In Norrland, as in other parts of Sweden, pastures on previously tilled soil can most easily be made to give a high yield per hectare. However, as regards the conversion of natural pasture (for example, woodland pasture) into cultivated pasture, satisfactory results can be achieved by a cheaper method of cultivation than that required for the use of the area as arable. If the ground can without inconvenience be ploughed, this is to be recommended.

That a thorough surface preparation is necessary for certain natural fields on their conversion into cultivated pasture has long been obvious. This would seem to apply above all to raw humus fields which are so common in Norrland and other parts of the country with extreme climatic conditions. Not least important, the control of *Aira caespitosa* is facilitated by means of a cultivation which favours the valuable grasses. A certain tendency to levelling as regards the botanical composition of the plant stand is, however, already noticeable in that *A. caespitosa* is beginning to gain an entrance even into deeply cultivated folds.

Regarding the species of plants for permanent cultivated pastures in regions with a severe climate, the difference in comparison with tracts where climatic conditions are more favourable extends mainly to the tall grasses which are usually included in sowing pasture leys in more southerly parts of the country, such as *Lolium perenne*, *Festuca pratensis*, *Dactylis glomerata*, which lack all significance for north-Swedish pasture fields. *Phleum pratense* on the contrary is of considerable importance not only in putting down leys, but also, and not least, for repeated supplementary sowing to the extent of the necessity for improving the stand. Such an addition of *P. pratense* to the pasture leys appears also for the rest to be appreciated by the grazing animals.

A cultivated pasture in the most northerly part of Sweden includes, broadly speaking, the same perennial, true pasture grasses as in more southerly areas, together with, as there, white clover, which may occur in almost greater abundance in northern cultivated pastures than in those further south. In the cultivation trials referred to above 3 kg. of " Ostergötland Mörso white clover " were sown. The admixture of white clover every year was quite abundant although somewhat unevenly distributed. Whether it is the white clover which was sown which persists, it is impossible to say. The white clover in the experiment is as a rule of quite considerable growth, but it is possible that the wild white clover attains to such development under favourable conditions. In any case there is evidently no reason to be prodigal with seed of white clover in sowing pasture leys in north Sweden, at least as long as thoroughly good seed of local origin is lacking.

Poa pratensis occurs abundantly naturally where the soil in Norrland is sufficiently rich in nutriment and otherwise suitable. Whether local origin is of any great importance, it is difficult to say. Although there was a small amount of *P. pratensis* in the original vegetation, particularly at Nordvik, it is evident that the general occurrence of this species as early as the second year was due to the sown seed. *P. pratensis* increased rapidly the first two years and the admixture was always abundant. The *P. pratensis* which originated from sown seed can, therefore, not have died out quite suddenly and been replaced by plants from unsown seed. If such had been the case a distinct falling off would have been noted in some years. That the original, small admixture increased in a high degree during the time is, however, very probable.

Agrostis vulgaris is the commonest grass, apart from *Aira caespitosa*, in Norrland pasture fields. This grass occurs, however, here, as in the more southerly parts of Sweden, most commonly on soils poor in nutriment when it is eaten with reluctance by animals. With a better supply of nutriment in the soil, the grass becomes more palatable. But on such soils the *A. vulgaris* soon becomes mixed with smooth-stalked meadow grass and white clover and yields there gradually to those plants, which in Norrland as well as in other parts of the country must certainly be regarded as a desirable development in the composition of the plant stand on pasture. In the Society's cultivation trials *A. vulgaris* seed purchased from North Bothnia was sown. The admixture of this grass is also abundant but unevenly distributed; where there is a good growth of smooth-stalked meadow-grass there is little or no *A. vulgaris*,

Festuca rubra grows well in the most northerly parts of Sweden. The original forms are not as a rule tuft-forming and occur, therefore, mostly mixed with other grasses, not least *Agrostis vulgaris*. In the cultivation trials, seed of Rex *F. rubra* was sown. It attains development slightly more rapidly than smooth-stalked meadow grass and at present the stand in the Brattby experiment is dominated by *F. rubra* with extended growth habit, uniformly mixed with other grass species and clover and also apparently readily grazed by animals. It may be remarked that the soil is naturally poorer at Brattby than at Nordvik, where smooth-stalked meadow grass predominates. *Poa serotina* and *Agrostis stolonifera*, which were also sown in the cultivation trials, have not appeared in the sward, but they did not occur in the original herbage either.

Poa trivialis grows wild to a large extent even in north Sweden, for example, in hay leys on humus soils. It will probably, however, not be of great importance for pastures there.

Alopecurus pratensis also grows well on ground which is not too dry. In northern latitudes or high above sea-level its early development is of course a valuable character in the spring but later results in the grass readily becoming overgrown. *A. pratensis* for the rest does not tolerate continuous grazing well.

Aira caespitosa has undeniably an important task to perform in the areas under consideration here, because without it many fields would more or less lack vegetation. *A. caespitosa* also develops early in the spring, does not demand soil of high fertility, and grows even on swampy ground. In addition it is rich in protein and possibly has the power to utilize the organic nitrogen fixed in the soil, which in that case would explain its vigorous development even when nitrification in the soil is reduced owing to low temperature or restricted air supply. In the tender stage *A. caespitosa* is eaten quite readily by animals, both fresh and in the form of hay. The reason for seeking to check this species in cultivated grass fields is more particularly because certain other plants give a more valuable fodder and frequently too a larger yield. (It is reported that the content of minerals in *A. caespitosa* is unsatisfactory or in any case not readily accessible to animals, and their development or production on *A. caespitosa* pastures does not contradict this.)

The most effective way of checking *A. caespitosa* in north Swedish pastures is to ensure the more desirable plants a vigorous and rapid development. Finally, one may possibly be compelled to put down anew a pasture ley where this species has become too prevalent.

The importance of the supply of nutriment for the achievement of a long grazing period is so obvious that it is unnecessary to deal with it at great length. It is unfortunate that naturally the soil in upper Norrland is in general poor in nutriment, and manuring is therefore much more important there than where the soil is more fertile. It cannot be said that the manuring per hectare requires to be more liberal than in more southerly districts and on better soil because the growing period is so much shorter. But calculated per food unit, manuring is more costly in the parts of the country with unfavourable climatic conditions, possibly in the first place owing to the poorer soil. It is a question too whether the nitrogenous manuring of pastures in districts with unfavourable climatic conditions is not in general of greater importance in achieving and maintaining a satisfactory yield from cultivated pastures than where the climate is more favourable.

In north Sweden the soil is to a great extent poor in lime. Liming, however, does not always give positive results in experiments. In the Society's cultivation trials one-third of the area is limed. It has not been possible to determine any quantitative result of that liming. There has been no perceptible effect at Nordvik, but at Brattby it has been possible up to the present every year in spring and autumn

to distinguish clearly the limed folds owing to their darker and healthier colour. In the early years this was more striking than, for example, during the spring of this year.

In laying down cultivated pastures in regions with severe climate it is very important to establish a dense and vigorous sward as quickly as possible, the density not least to exclude *A. caespitosa* and the vigorous growth to ensure the first overwintering. It is therefore necessary to use a comparatively heavy rate of seeding even though the lion's share possibly must consist of timothy. Sowing should be carried out without a nurse crop and in such good time that the meadow plants are well grown before the winter sets in. Practical experience and a large number of experiments have confirmed the advantage of pure sowing of seed of meadow plants.

Care must be taken to ensure that the sward remains dense. So-called ice-burn frequently causes gaps in north Swedish swards. A liberal amount of timothy seed and a small quantity of clover should be sown on bare patches.

Injuries to the sward by snow mould should be remedied as soon as possible.

Pasture fields should not be subjected to continuous grazing. Overgrazing of cultivated pastures frequently results in *A. caespitosa* gaining an entry more rapidly.

RATIONAL PRODUCTION OF SEED OF MEADOW PLANTS

[Reviewer: R. Peter Jones]

[An address delivered by O. Valle at the Finnish State Seed Exhibition, February 25, 1939. *Tidskrift for Lantmän* 21. 37-41. 1939.]

Seed production of meadow plants in Finland has made rapid progress during the period of the country's independence. This applies both to the amount and the quality of seed. The production of seed of timothy, Finland's most important meadow grass, has for many years been so abundant that some of it is exported. Production of red clover seed has also advanced. In the spring of 1933 the import of red clover seed was forbidden. Seed of alsike is still imported from abroad, either from Sweden or Latvia. During certain years the import of alsike seed exceeded 100,000 kg. Recently, however, it has been about 20,000 to 30,000 kg. Seed of *Alopecurus pratensis* is to a large extent exported.

The greater part of the seed of pasture plants proper is imported. Production in Finland has comprised only small amounts of seed of meadow fescue, cocksfoot, red fescue and smooth-stalked meadow grass.

Seed production of meadow plants must be developed still further as the technique leaves much to be desired. The reason why there has been an appreciable improvement in the quality of seed of meadow plants, particularly as far as red clover is concerned, is that modern, effective quality graders have come into general use. The introduction of payment according to quality of timothy seed has been followed by a great improvement in the quality of the seed produced.

Red Clover

There has been a marked increase in the demand for red clover (*Trifolium pratense*) in recent years. Next summer an effort should be made to produce larger

amounts of seed than hitherto. Production of red clover seed for trade requirements has naturally been most extensive in south-west Finland, as seed production is most certain there. South-west Finland now produces 60 to 70 per cent of the commercial seed of red clover. Having regard to ley cultivation, it is of importance to investigate the possibilities of production of red clover seed in the present under-production areas in east Finland. Weather conditions may vary considerably during the same summer in the south-western and eastern parts of Finland, so that the possibilities for production of red clover seed may be different during the same growing period in different parts of the country.

Hitherto seed of red clover has been taken for the most part from ordinary hay leys. Special seed leys consisting exclusively, or preponderantly, of red clover are still very rare in Finland. At the Plant Breeding Station at Tammisto, investigations have been conducted during the last six summers to elucidate certain facts connected with seed production of red clover. Some of the results of practical importance are referred to below.

Hitherto the opinion has been fairly general that red clover gives the best yields on warm hillside fields sloping towards the south. This is, however, not the case, at least not during warm summers, because the more favourable the growing place of the clover is, the earlier does red clover begin to flower. As the worker humble bees that carry the pollen in fertilization always emerge relatively late, at the time when flowering in red clover is at its zenith, the seed yield is smaller the earlier the red clover had begun to flower. Seed formation during normal summers is much more abundant on level, open arable fields. During wet years seed ripening may, however, be more certain in fields on hillsides. On different soils even on the same farmstead, seed production may vary noticeably, probably owing to the fact that honey in the clover florets varies in amount on different kinds of soils. The more honey there is in the florets, the larger is the number of humble bees in the seed plots ; on clay mould soils honey is present in the florets in larger amount than on dry sandy soils.

Unfortunately, no means is known whereby an increase in the number of useful humble bees can be effected. Honey bees too, can take part in the fertilization of clover florets, but under Finnish conditions, according to investigations conducted up to the present, they are of but little significance.

In Finnish seed production the control of insect pests of red clover seed has not yet received attention. *Apion apricans* can, however, cause very great damage. At Tammisto during the summers of 1936 and 1937, a Danish poisonous powder containing fluorine, cryocid, which is only half the price of arsenical powders, was used with success. In the summer of 1937 the seed leys at Tammisto were dusted with 15 kg. per ha. 80 per cent cryocid. In a third year seed ley, where the pests were present in large numbers, the seed yield rose after dusting by 53 per cent, namely, from 201 kg. to 312 kg. per ha.

By paying attention to certain points in cultivation technique, the seed yield can be increased considerably. At present seed yields in practice vary between 200 and 300 kg. per ha., frequently they are still lower. During the summers of 1936 and 1937, which certainly were relatively favourable for seed production, at Tammisto yields of 600 kg. per ha. were obtained from pure red clover leys.

In Finland commercial seed of red clover comes on the market too late. Threshing should be carried out earlier.

Alsike Clover

The seed requirement is not particularly large in Finland, but it is nevertheless to be deplored that only 5 per cent of the alsike (*Trifolium hybridum*) seed on the

market is indigenous. Seed production of alsike should be extended so that Finnish needs may be met by indigenous seed.

At Tammisto investigations have been conducted on seed production of alsike clover, as a result of which it can be stated that the seed plots should be put down without timothy as timothy seed can only with difficulty be separated from alsike seed. At Tammisto seed has been sown in drills and it is then easier to control weeds than when the broadcasting method is used. It should be remarked that the removal of weed seeds from alsike is much more difficult than from red clover even though the very best sorting machines are employed. This is due to the fact that the seeds of many species of weeds are the same size as those of alsike.

Bees are the principal fertilizers of alsike clover florets. Thus the largest yields of alsike are obtained in districts where bee keeping is general.

The seed of alsike ripens earlier than that of red clover. The greatest drawback in seed production appears to be that the seed germinates readily in the field during the ripening period. If the weather is damp and rainy the ripe seed frequently germinates before the seed hay is cut. For this reason the seed hay should be dried rapidly and should be left on the poles for as short a time as possible. Rain shelters may be used to facilitate the drying of the seed hay on the field.

Usually only one seed crop of alsike is taken. If, owing to earliness of the summer, the seed hay is cut from July to August, the seed ley may recover sufficiently for another seed crop to be obtained from the same ley during the following year.

The yields obtained from the seed plots at Tammisto prove that alsike can give abundant and valuable seed yields.

White Clover

The most important clover species of pasture. The indigenous Tammisto strain of *Trifolium repens* has already been produced, but it has not been possible to place it on the market yet owing to difficulties of seed production. It is highly desirable that white clover seed produced in Finland should be obtainable on the market, as not even the most suitable foreign strains, such as Danish Morsø white clover, are sufficiently hardy for Finnish conditions.

Timothy

In Finland, timothy (*Phleum pratense*) seed is of greater importance than the seed of any other meadow plant : the country produces annually 6 to 8 million kg. timothy seed. The seed is taken from ordinary hay leys where the timothy grows as pure and as weed-free as possible. There has been an improvement in the quality of the seed during the last two decades, as shown by the weed content which in barely 20 years has fallen from 2 per cent to less than 1 per cent.

The reduction in the weed content has been favourably influenced by the quality payment system of the Hankkija Central Association which was initiated in 1930. According to this system, the purchase price depends on the weed seed content of timothy.

The quality payment system has since been adopted by other firms which purchase timothy seed. The new quality sorting machines, which during recent years have come into use in districts where timothy seed is produced, have been a further reason for the reduction in the weed content of timothy seed leys.

In Finland there are four large areas for the production of timothy seed, Middle East Bothnia, South East Bothnia, Satakunta and South West Finland. As a rule the East Bothnia timothy seed contains more weed seeds than seed from Satakunta and South-west Finland.

Hitherto the following weeds in timothy seed have been counted as noxious: *Barbarea vulgaris, Rumex acetosella, Chrysanthemum leucanthemum, Matricaria inodora.* From the beginning of this year the seeds of *Rumex acetosella* will not be regarded as noxious weed seeds. Previously there was a general regulation that in commercial seed of timothy there should not occur more than 1.5 per cent weed seeds: now a stricter regulation is in force, according to which parcels of timothy seed must not contain more than 5,000 noxious weed seeds per kg.

Production of timothy seed in Finland has generally speaking been too great, and, therefore, the production of commercial seed should be restricted to the present areas of cultivation. The quality of the seed should be improved still further. This applies not only to the weed seed content and the occurrence of hulled seeds, but also to the colour. A bright colour with a silvery lustre always increases the value of commercial seed of timothy.

Meadow Foxtail

Alopecurus pratensis is considered an important meadow plant, and large quantities of seed are exported annually. There are no regular seed plots in Finland, but seed is collected from ditchbanks and roadsides. The export of seed is seriously hampered by poor quality: low purity and high weed content. The technique of seed production of this species should be the subject of investigation so that the quality might be improved.

Finnish growers should turn their attention to seed production of meadow fescue, cocksfoot, red fescue, smooth-stalked meadow-grass and possibly also perennial rye-grass. The demand for these species is certainly small, but it would grow with an extended pasture cultivation. Finland has its own strains of various pasture plants which are more hardy than foreign strains. An incorrect cultivation technique has placed obstacles in the path of seed production of these less important meadow plants. The writer considers as of special importance under Finnish conditions seed production of meadow fescue, which next to timothy is the most important grass species.

HOLT, THE MOST NORTHERLY AGRICULTURAL EXPERIMENT STATION IN THE WORLD

[Reviewer: R. Peter Jones]

At Holt, the most northerly agricultural experiment station in the world, a series of trials with seeds mixtures has been completed. (Streif gjennem de senere års forsøksresultater. [A glance through the experimental results of recent years.] K. Fjaervoll (Director of the Norwegian State Agricultural Expt. Station at Holt, near Tromsø). *Norsk Landbruk* 4. 321-24. 338-40. 1938.)

Strain trials with timothy and overwintering trials with timothy, meadow fescue and cocksfoot were particularly interesting.

Strain trials. In the first strain trials with timothy, Finnish timothy (from the Våsa region), Valstand (Trøndelag), Swedish (commercial), Grindstad (seed grown in east Norway) and Danish timothy were included.

The strain trials were extended by the inclusion of recognized north Swedish strains, local grown seed of Engmo timothy from the province of Troms and a strain from the Nordland School of Agriculture.

These trials have shown that timothy seed from America, Denmark and south-east Norway produces a poor ley in the province of Troms with a small total yield of hay and a small yield of pure timothy hay per dekar ; the persistency of the ley is poor.

The trials have also shown clearly that timothy seed of strains grown for seed in North Finland, North Sweden (Botnia) and in Trøndelag (Valstad) gives rise to a ley with a larger total yield of hay, a larger yield of pure timothy hay per dekar, and a more winterhardy and persistent ley than timothy seed produced in America, Denmark and East Norway. The best of these strains have given a 30 to 35 per cent larger total yield of hay per dekar and a 60 per cent larger yield of pure timothy hay.

Timothy seed produced in Nordland and the province of Troms gave a larger total yield of hay, a larger yield of pure timothy hay per dekar and a more winterhardy and persistent ley than any of the other strains mentioned.

Overwintering of timothy (*Phleum pratense*). Average figures for five " overwinterings " show that the number of overwintered plants is more than three times as large for Engmo timothy, seed produced in Troms, as for timothy seed produced in the south-eastern part of Norway.

Overwintering of meadow fescue (*Festuca pratensis*). The overwintering trials with meadow fescue show that there is not so great a difference in overwintering capacity between local-grown seed, other Norwegian grown seed and seed from abroad as there is in timothy. The overwintering percentage is highest in plants originating from local-grown seed of Finnish origin and the Løken strain from Valders. The Vollebekk strain is superior to the Lyngby strain in overwintering capacity. The overwintering percentage is higher in meadow fescue than in timothy.

Overwintering of cocksfoot (*Dactylis glomerata*). For cocksfoot there have been five " overwinterings." The highest overwintering percentage was found in plants originating from seed produced locally. Here the overwintering percentage is almost as high as in meadow fescue. The difference between local strains with local seed production and strains grown for seed in South Sweden and Denmark is very great.

Strains grown for seed in south-east Norway are decidedly better than the foreign strains which have been tested, with the exception of north Finnish. Danish cocksfoot is decidedly inferior to the other strains and has a very poor overwintering percentage.

Seed of the local strains from Troms shows very poor germination when sown in the spring. Germination is good when the seed has lain in the soil from autumn to spring.

Time of cutting timothy. For eight years time-of-cutting trials have been in progress at the Station. In connexion with these trials fodder analyses have been carried out during six years and chemical analyses during eight years for all the times of cutting. The times of cutting were : 1. At the height of panicle emergence in timothy ; 2, at the beginning of flowering ; and 3, a fortnight after flowering. The first time of cutting gave 603, the second time of cutting 841, and the third 884 kg. hay per dekar on the average of eight years.

The amounts of crude protein and of digestible protein rose uniformly from the first to the second time of cutting and decreased to the third time of cutting. The food unit concentration on the average of six years was 56, 45 and 42 for the first, second and third time of cutting respectively. After evaluation of the various factors in connexion with technical and climatic conditions, the conclusion arrived at is that the most advantageous time of cutting for timothy leys in the district is about the flowering stage.

ANNUAL REPORTS

GREAT BRITAIN

Rothamsted Experimental Station, Harpenden. (1936 and 1937).

The report for 1936 summarizes the results of several years' work on grassland investigations. Problems relating to soils, manuring and grass composition fall within the scope of the Rothamsted programme. The following aspects are discussed in detail:

(a) *Botanical composition of manured meadowland.* The work of Brenchley, *Herb. Abstr.* 5. 211-2. 1935 completes the data to 1934 and subsequently a five-year cycle of analyses has been begun on specified plots to obtain information as to the correlation between seasonal effects and potash manuring.

(b) *Seeds mixtures and botanical composition of resulting herbage.* See *Herb. Abstr.* 8. Abs. 928. 1938.

(c) *Experiments on weed control by sprays.* It is concluded that thiocyanate is an uncertain agent for weed reduction on grassland, but it has a good temporary effect especially in a dry summer.

(d) *Legume-grass associations.* For published data see Thornton and Nicol, *Herb. Abstr.* 4. 111. 1934, 5. 49. 1935 and 6. 299-300. 1936.

(e) *Fertilizer experiments.* Consideration is given to availability of different forms of nitrogen (herbage yields from certain seasonal applications and under different cuts), and to effect of phosphatic fertilizers on grassland. Data are tabulated on pp. 33-5 of the 1936 report.

(f) *Composition of ryegrass.* Study is made of chemical composition under weekly cuts during the whole of the active growth period and of second cuts from the same plots later in the season. The most notable feature was the change, as maturity approached, of water-soluble fructosan, a major constituent of young grass. At the time of full emergence of the head this increased to a maximum and then decreased rapidly until in very old grass none was found. It has further been revealed that the stem is the chief place of storage of this polysaccharide. When maturity is reached there is no increase in total dry weight of the plant although there is subsequently a steady rise in the proportions of the cell-wall constituents and particularly of cellulose. With the concurrent fall in fructosan there is the strong possibility that much of the stored fructosan is transformed later into structural material.

The second growth differed from the first in containing less fructosan and being higher in structural cell-wall constituents. It would thus appear to be more fibrous and if differences in composition between first and second cuts of *Lolium* are confirmed in other grasses, a revision will be necessary in the policy of drying frequent cuts throughout the season.

The report for 1936 also contains results of study on (1) the relation of cultivation to root crop yields. Under conditions of the trials it is shown that yields are not greatly dependent on cultivation methods. (2) The effect of fertilizers on forage mixtures. In trials extending over 1930-3 evidence has been obtained that nitrogenous fertilizers increase the yield of autumn and spring sown mixtures of various

components including wheat, oats, barley, peas, vetches and beans, but the increase was made in the cereal component, the legumes suffering from the intensified competition so that protein yield was not increased. In 1932 and 1933 experiments were made to determine the optimum ratio of sowing rates for oat and vetch mixtures and to test the possibility of sowing forage mixtures in July to provide green material for drying in autumn and again in the following spring. Ryegrass and six-row barley gave the best yields at these times, and the yield and protein content were increased by the addition of beans and vetches or trefoil. (3) Comparison of temporary leys and fallow in preparation for wheat. During 1931-6, leys of ryegrass, clover and mixed clover and ryegrass were used. Results showed that yields of wheat following fallow were greatest, that clover was a better preparation than ryegrass, and that the mixture produced intermediate yields in the succeeding wheat. The taking of a second cut from the ley, particularly of the ryegrass and ryegrass-clover mixture, depressed wheat yield.

Study of the effect of treatments on physiological processes in crop plants involves determinations of rate of increase of dry matter per unit area of leaf as a measure of the balance of photosynthesis and respiration. No direct method for the estimation of leaf area in field crops is available, but an indirect method is recorded by D. J. Watson in *J. Agric. Sci.* 27. 474-83. 1937.

Observations on fungous and other diseases on plots at Rothamsted and Woburn include those of *Epichloë* on *Agrostis*, *Peronospora Trifoliorum* and *Sclerotinia Trifoliorum* on clover, and chocolate spot of beans.

The Farm Report for 1936 includes an account of rotation, cropping and harvesting (from grassland) experiments in progress.

National Institute of Agricultural Botany, Cambridge. (1936-37).

CROP IMPROVEMENT BRANCH.

Field trials and observation plots.

The following *Medicago* strains were sown during 1937 in trials in the Isle of Ely and in West Suffolk: Hungarian, Registered Provence, Grimm, Ontario Variegated, Rainy River and Mixed Provence, Hungarian and English Provence. The strains were also sown in a trial at Newport (with the exception of the mixed stock).

Numerous strains are grown in observation plots at Cambridge and at the Experimental Farm, Cockle Park.

Trials of *Onobrychis* sown at Cambridge, Cirencester and Long Sutton in 1935 have shown great differences between strains.

OFFICIAL SEED TESTING STATION.

Diseases of economic importance recorded on seed samples during the year included: *Claviceps purpurea* in various grasses; *Ascochyta pisi* and marsh spot in peas and *Aplanobacter ratheyi* in *Dactylis*.

For work on germination of peas after dusting with organic mercury compounds see Brett and others, *Herb. Abstr.* 7. 64. 1937.

Under the Wild White Clover Certification Scheme the Station receives each year samples of clover heads from fields entered and inspected under the scheme and also type samples from pastures which have been finally certified. Plots are sown from all the samples and up to July, 1937, totalled 1,022.

Wye, Kent. South Eastern Agricultural College. (1939).

Department of Entomology. Records of attack on pulse and clovers include the following: *Contarinia pisi* on peas (often associated with *Kakothrips pisivora*);

Heterodera schachtii on a crop of seed peas ; a large race of *Anguillulina dipsaci* on tick beans, which race has only once previously been recorded in England.

Department of Mycology. Clover stem rot caused by *Sclerotinia Trifoliorum* has been recorded in different parts of Kent. A crop of *Trifolium pratense* was attacked by *Anguillulina dipsaci* and also by *Orobanche.* The possible harmful effects of *Clavaria vermicularis* and *C. fragilis* in pastures near Lewes, Sussex, and near Sidmouth, Devon, have formed the subject of enquiry, and attacks on field beans have included those by *Sclerotinia Sclerotiorum* and *Botrytis cinera.*

Department of Botany. Replicated experimental plots were laid down in spring, 1938, on the shingle on the landward end of the Holmstone beach, Dungeness, to test the possibility of growing selected grasses, clovers and shingle plants on a foundation of ditch clearings spread on shingle. In preliminary trials, about eighteen different species of grasses and clovers were sown broadcast, singly, and in single and compound mixtures. Under specified treatment and with irrigation it is concluded that spring sowings cannot be successfully established under the low rainfall conditions of the locality. Further experiments are in progress with the same species and mixtures but fertilizer and inoculation trials are omitted. Tests are made of time and rate of sowing and of tilth fineness on germination and survival. A survey of the vegetation is being undertaken and it is evident that the presence of plants is associated with small shingle size and relative proximity to the sea. In connexion with these studies data have been obtained on germination of *Lathyrus maritimus* and results published. (*Herb. Abstr.* 9. Abs. 353. 1939.)

The following four new angiospermous host plants of *Cuscuta Epithymum* on pasture of the College Farm are recorded : *Ranunculus bulbosus, Rubus fruticosus, Pastinaca sativa* and *Phleum pratense.*

Chelmsford, East Anglian Institute of Agriculture. (1936-1938).

The Institute farm, situated at Writtle, has been organized with a view to establishing a sound farming system, and improving the grassland. Following mechanical treatment the adoption of a sound policy of grassland management is in view.

The activities of the Essex Seed Growers' Association (started five years ago for the purpose of certifying the best strains of Essex Late Flowering red clover) are recorded. The crops inspected for the Association by the Institute include Essex Late Flowering *Trifolium pratense,* Essex Broad Red, and many Aberystwyth strains of pedigree grasses and clovers. It is intended to appoint a qualified Seeds Officer for this work.

Work is in progress on the manuring of *Dactylis* for seed production, the nitrogen requirement of wheat and the manuring of sugar beet.

The value of *Spartina Townsendii* as an emergency fodder has been recorded in earlier reports of experimental work carried out in Essex.

Sutton Bonington, Midland Agricultural College. (1936-1938.)

The following are among problems receiving investigation : use of sprays and dressings in control of the more important farm weeds ; botanical problems associated with grass drying ; the use of plant hormones as aids to propagation by cuttings ; the relative viability and dormancy of weed seeds ; pests of peas and of grassland ; the improvement of turf for lawns and sports grounds (forty-two small plots have been laid down to study the effect of varying soil conditions—chemical and physical —on the growth of various fine-leaved grasses) ; methods of sampling and analysing grass and other fodders ; and manganese deficiency in crops (cereals and root crops).

Board of Greenkeeping Research, St. Ives Research Station, Bingley, Yorkshire, 1937.

The investigations in progress on grasses are summarised under the following headings :—

1. Seed Production. Improved strains of *Agrostis tenuis* and *Festuca rubra* have been developed. Seed production has been studied in critical experiments and on large scale sowings and supplementary work has also been made in co-operation with the Essex Seed Growers Association, and on the farm of the Macaulay Institute on the Island of Lewis. Effects of broadcast and drill sowings, nitrogen and phosphoric acid, inter-row cultivation on yield of seed have been investigated.

2. St. Ives Creeping Red Fescue. This is the first new strain produced at the Station and seed has been available to subscribing clubs of the Board for sowings during the past season. An improved strain of *Agrostis tenuis* is now undergoing multiplication for the same purpose.

3. Seeds Mixtures. Trials of species sown alone and in mixture have been carried out during the past 10 years and are being continued, particularly with a view to the inclusion of the new strains. Species examined in this way include *Agrostis tenuis* (New Zealand browntop), *Agrostis canina*, *Agrostis stolonifera*, *Festuca rubra* var. *fallax* (Chewing's fescue), *Festuca rubra* var. *genuina* (true creeping red fescue), *F. rubra* S 59, *F. longifolia* (hard fescue), *Cynosurus cristatus*, *Lolium perenne* (S 23 and other strains).

4. Timothy Grass (*Phleum pratense*). Turf forming experiments are in progress with several dwarf pasture types.

5. Velvet Bent (*Agrostis canina*). Practical trials are in progress on the value of this species ; an area of 800 square yards is now under actual playing conditions on a golf green.

6. Grasses from Other Countries. Comparative experiments are made periodically with turf formed from different strains of bent grasses (from New Zealand, U.S.A., Canada), with particular reference to their winter hardiness, and observations are made on exotic grasses, e.g., *Cynodon* spp., *Zoysia* sp., *Digitaria* sp., *Paspalum* sp., *Stenotaphrum* sp.

7. Root Development. Data are available, following preliminary studies, of the root development of turf of *Agrostis tenuis* cut at different thicknesses.

8. Fungal Diseases. Closely mown turf is susceptible to a number of fungal diseases, particularly *Fusarium nivale*, *Corticium fuciforme*, *Sclerotinia homoecarpa*, *Marasmius* spp. and others giving rise to fairy rings. Work connected with their control is in progress.

9. Other Diseases. The likelihood of eelworm damage to the fine grasses has received some attention.

10. Fertilizers. Extensive trials have been under observation since 1929. Recently additional trials have been laid down on *Agrostis tenuis* turf to investigate in greater detail the more important results already obtained, e.g., the effects of nitrogen, phosphoric acid, calcium, calcined sulphate of iron, compost and spiking alone and in combination.

11. Mowing. The effect of close cutting upon the development of a sward has been investigated ; and a new experiment involves comparisons of different intensities and frequencies of cutting, and of variation in time of commencement of cutting in the spring and cessation of cutting in the autumn.

12. Topdressings. The effect of topdressing with compost mixtures upon the different grass species has been studied.

13. Effect of Lead Arsenate on Germination. Powder lead arsenate is a valuable insecticide ; on soil treated prior to sowing, the percentage germination of *Festuca rubra* var. *genuina* (Indigenous), *Festuca rubra* var. *genuina* (Commercial),

Festuca rubra var. *fallax* (Chewing's fescue), *Lolium perenne*, *Poa pratensis*, *Poa trivialis*, *Poa annua*, *Agrostis tenuis* (New Zealand browntop), *Agrostis canina*, *Cynosurus cristatus*, is unaffected, although the subsequent growth of *Cynosurus cristatus* is somewhat retarded.

14. Potassium Permanganate. Potassium permanganate has been investigated as an earthworm eradicant for turf and the optimum rate ascertained. The value, at economic levels, of this compound for controlling moss and accelerating oxidation of organic matter in the soil is still under investigation.

15. Leather Jackets. One method of control consists of bringing the larvae to the surface of the turf with an emulsion of orthodichlorobenzene and Jeyes Fluid. Following work with lead arsenate as an earthworm eradicant, trials also showed its value in some circumstances for controlling leather jackets.

16. An Exhibition of greenkeeping tools, implements and machinery has been permanently established so that members of subscribing clubs may examine at their leisure the latest developments in greenkeeping equipment and examine different types of mowers, rollers, spiking machines, sprinklers, tractors and accessories when they are considering purchasing of new equipment for their own courses.

Cockle Park Agricultural Experiment Station (1938).

Cockle Park is the experimental farm of Northumberland County Council; the research work is directed by Professor J. A. Hanley, King's College, Newcastle-upon-Tyne, and includes :—

(1) The original manurial trials (laid down by Somerville in 1896) on Tree Field. Basic slag has proved the most effective fertiliser judged by live-weight gains of sheep. On Hanging Leaves with mixed grazing on the same heavy boulder clay soil the results are similar, but the total live-weight gains are double (cattle and sheep) those on Tree Field. This mixed grazing also gives better herbage control and the sheep do better individually because of a wider grazing range.

(2) Chemical examination of soil and herbage on Tree Field. This has revealed a 50 % increase of protein and 100 % increase in P_2O_5 wherever phosphate has been used. The addition of lime has doubled the CaO in the herbage. Only 8 % to 11 % of the P_2O_5 added during 42 years has been removed by live-stock. Most of the balance of the P_2O_5 is in the surface soil. *Herb. Abstr.* 8. Abs. 28. 1938. Methods of utilising this reserve are under investigation.

(3) Meadow hay experiments on permanent grass. Different manurial treatments have produced marked changes in yield and quality. The influence of these changes on nutritive value and on losses during haymaking have been determined. *Herb. Abstr.* 8. Abs. 1758. 1938. On Long Riggs the effects of various methods of managing permanent grass, mown every year for hay, on hay yields and quality are under investigation.

(4) Grazing management on permanent grass land. On Roundabouts Field is an experiment on the influence of rest periods on the character of the herbage with special reference to production of spring and winter grazing. *Herb. Abstr.* 7. 34. 1937.

(5) Trials with seeds mixtures and various strains of grasses with reference to suitability for: (*a*) grass drying and grass silage, (*b*) long leys, including alternate husbandry. Genuine Kentish indigenous perennial ryegrass sown 20 years ago has retained its characteristics and the plots have resisted weed invasion.

(6) Methods of ploughing out poor grass land and resowing as a means of increasing fertility on heavy and light soils.

(7) The conservation of grass as a winter fodder. Trials are being made with a grass drier and silos, the products being used in feeding trials during the winter. In addition investigations into the carotene contents and methods of determining carotene in dried grass and grass silage are in progress. *Herb. Abstr.* 8. Abs. 2009, and 9. Abs. 393, 394 and 901. 1939.

Aberystwyth, Welsh Plant Breeding Station (1938).

Work of the Station is concerned with all aspects of pasture production, maintenance and improvement (notably extended under the Cahn Hill Improvement Scheme. See Stapledon, *Herb. Abstr.* 5. 136. 1935). Breeding work with pasture grasses and clovers is in progress and with regard to the grasses *Lolium perenne*, *Phleum pratense*, *Dactylis glomerata*, *Festuca* spp., and *Alopecurus pratensis*, seed is produced for marketing or for extended sward trials.

Plant selection and strain building have resulted in the following material being available for distribution : three strains of *Lolium perenne* (one pasture and two hay-pasture types), three strains of *Phleum* (one hexaploid pasture, one diploid pasture and one hexaploid hay), three strains of *Dactylis* (pasture, pasture-hay and dense hay), one strain of *Festuca pratensis* (pasture-hay), and one each of *Festuca rubra* and *Alopecurus pratensis*.

The improved strains are tested in seeds mixtures with other grass and clover species, the object being to produce valuable and persistent plants for long leys and permanent pasture, for palatability, winter feed, and yield for shorter leys. The seeds mixtures trials also involve tests with different systems of management, sowing date, manuring, and persistency under competition. Analytical work on the composition of the grasses is carried out with the co-operation of the Agricultural Chemistry Department of the University College, Aberystwyth.

The breeding of improved clovers and other pasture legumes, and their testing in seeds mixtures are also carried out on an extensive scale. The genetical causes of self-sterility have been worked out and strain building with *Trifolium pratense* is studied with the object of producing (1) an early flowering strain for one-year leys ; (2) a strain resistant to *Sclerotinia trifoliorum* ; (3) a semi-late strain for two-year leys ; (4) a persistent extra-late strain for three-year leys ; and (5) a hardy strain for poor conditions. In regard to *T. repens*, the object is to produce (1) an improved early strain for one to three-year leys ; (2) a persistent strain for long leys and permanent pasture, and (3) an improved intermediate type. An attempt is being made to isolate pure line early and productive types of *T. incarnatum* and to obtain pure lines of lucerne from which to develop a strain suitable for the west country. One strain each of red and white clover is multiplied for distribution and preliminary trials with fourteen other strains of red and three of white are also in progress.

Wild white clover is sown to test its persistence in the marsh-land reclamation experiments. These involve mowing, grazing, ploughing and manuring areas where rushes and sedges flourish.

Following the installation of a grass drier, a series of experiments is made to test dried grass as a supplementary feed for sheep wintering in the open.

Oat breeding and selection are also undertaken at the Station because of the importance of this crop, especially in the Welsh uplands, and among miscellaneous researches is included the study of buried viable seed population in hill pastures and fields.

For details of the above work reference should be made to data published in the Station's Bulletins and the *Welsh Journal of Agriculture*, and abstracted in *Herbage Abstracts*.

Board of Agriculture for the Isle of Man, Knockaloe Experimental Farm, Peel (1937 and 1938).

Experiments on the manuring of hay have been in progress for some years and data are available of yields obtained under different treatments. There are also experiments concerned with the comparative values of special strains of grasses and clovers. Particulars of mixtures and yields are given in tabular form and observations have been made of relative grazing values.

Trials started in the 1938 season include: (1) the comparing of Knockaloe perennial ryegrass with Ayrshire and Irish strains in mixtures under a specified seeding rate. The following average yields per acre were obtained from triplicate sowings: Knockaloe ryegrass 80 cwt. 80 lb.; Ayrshire ryegrass 71 cwt. 101.5 lb.; and Irish ryegrass 71 cwt. 106 lb. (2) Comparison of yields from commercial and indigenous strains of grasses and clovers. (3) Yields from mixtures which contain different strains of *Dactylis*, and (4) yields from mixtures which contain different strains of *Lolium perenne*, *Dactylis* and *Phleum*.

An experiment on sowing a mixture of ryegrass and wild white clover under a cover crop of oats failed because the oat crop lodged badly. Sowings of the same mixture under a cover of rape (2, 4, 6 and 8 lb. respectively) gave satisfactory grass seed yield, with no apparent difference resulting from the rates at which the cover crop was sown.

Edinburgh and East of Scotland College of Agriculture. (1935—1937).

Investigations on hill pastures at Boghall are continued with special regard to improvement of poorer types dominated by *Nardus stricta*, the destruction of mat by mechanical means combined with phosphate manuring, and the introduction, by seeding, of useful herbage. The study of seed inoculation and liming for the establishment of *Trifolium repens* on poor pastures has shown that inoculation has been without effect but lime is beneficial, providing conditions are otherwise favourable for seedling establishment. The best establishment of clover occurred on an area which had previously been treated with basic slag and the effect of lime on this area was not so pronounced. The work on improvement of hill pasture by means of artificial irrigation with spring water has been published. See Heddle and Ogg, *Herb. Abstr.* 6. 144. 1936. Other publications of researches in the area include those of Fenton, *Herb. Abstr.* 7. 97 and 364. 1937.

Experiments on pasture manuring are in progress and periodic botanical analyses are made of induced changes in the herbage. (See Heddle and Ogg, *Herb. Abstr.* 8. Abs. 44. 1938.)

In the Department of Chemistry, soil and herbage analyses have been made in the study of pine disease of sheep. There is no conclusive evidence that a deficiency of iron, copper or manganese is responsible for the disease and investigations with regard to cobalt are in progress.

At the College Farm experiments are made on (1) tripod curing of hay; (2) variety trials with sugar beet (Russian strains show a tendency to bolt), soybeans (a two years' trial has shown that the crop is unsuited to the climatic conditions of the area) and Egyptian clover (one strain of which has shown considerable promise for the first time in 1937).

North of Scotland College of Agriculture. (1934-1937).

In collaboration with the Macaulay Institute for Soil Research and the County Work Department of the College, trials are in progress to determine the optimum seeds mixture for reclaimed peat, and the possibility of improving hill and moorland

grazings by means of cheap seeds mixtures and manurial dressings, with minimum cultivation. The experiments, located in North Uist, Lewis, East Aberdeenshire, Sutherland, Ross-shire, Orkney and Shetland, prove that moorland pasture may be considerably improved by the application of lime and phosphates and a sowing of 2 lb. wild *Trifolium repens* with 3 to 4 lb. each of *Cynosurus* and *Poa trivialis*.

At Craibstone, plots have been established and recordings are made of the characteristics of varieties and strains of clovers and grasses under different systems of planting, seed mixtures, manuring, grazing, etc.

Other research in progress includes the relation between seed germination in the soil and under laboratory conditions, weed eradication and the suitability of grass species, varieties and mixtures for lawns and golf greens, and the use of ultra-violet light in the examination of agricultural products. Results of the turf investigations have been published by Clouston, *Herb. Abstr.* 8. Abs. 2085. 1938.

Hannah Dairy Research Institute, Kirkhill, Ayr. (1934-1937).

In order to determine the yield of young grass obtainable under the climatic conditions of south-west Scotland, plot experiments were started during 1932. From one intensively manured plot the yield of dried grass during the first year amounted to nearly 6 tons per acre. A fall in amount in subsequent years has been remedied by heavy dressings of farm manure. Data are to be published shortly.

Methods of ensiling and artificial drying are being studied and two types of grass-drying plant have been installed, the " P and M " machine and the Ransome machine. Difficulties are involved in assessing the extent to which artificially dried grass can be economically produced on an average-sized dairy farm owing partly to the variable rate of grass growth (especially in spring). Variations in protein content of the product (ranging from 10.5 per cent to 25 per cent in the experiments) depend on condition of the grass at cutting time and on differences in the level of nitrogenous manuring. Temperature used in artificial drying had no adverse effect on protein quality. The work of Morris, Wright and Fowler noted in *Herb. Abstr.* 6. 381. 1936 records that there are differences in biological values of the proteins in spring and autumn grass. It has further been found that the change in value normally occurs towards the end of September. However, the proteins of autumn grass have as high a biological value as those of bean meal.

Scottish Society for Research in Plant-Breeding, Corstorphine, Edinburgh. (1934-1937).

Breeding work with *Phleum*, *Dactylis* and *Lolium* is reported and investigations on the requirements of different strains with regard to environmental conditions have been initiated by the establishment of observational grazing trials located in various parts of Scotland. Data are available regarding the relative uses in pasture of 'diploid' timothy and the commonly cultivated 'hexaploid' type.

General problems of crop improvement are also studied and include methods of seed production, the maintenance of cross-fertilizing strains at a desired level of purity and the influence of environment on the heredity of plants composing a freely crossing population. See Gregor and Horne, *Herb. Abstr.* 5. 179. 1935.

Measures for the utilization of the plant breeders products have been reviewed by Gregor, *Herb. Abstr.* 3. 147. 1933.

A research programme dealing with natural populations of *Phleum* and *Plantago* has been in progress since 1926. The object of this work is primarily to study the factors affecting population differentiation and also to examine the possibilities of devising a genecological classification of crop plants based on experimental evidence. See *New Phytol.* 30. No. 3, 1931, ibid. 35. 323-50. 1936, and ibid. 37. 15-49. 1938. *Herb. Abstr.* 9. Abs. 7 and 251. 1939.

For the renovation of poor, bent-dominated pastures ploughing and reseeding is frequently the most economical method. A possible alternative would be the sowing of an annual pasture comprising quick-growing races which do not demand a fine tilth for germination and subsequent growth. A study of hardy, quick-growing annuals has, therefore, been initiated. Renovation by vegetational stages may thus consist of the following phases: (1) pasture comprising large-seeded annuals; (2) a wild white clover or soil-fertility raising phase; and (3) a long duration pasture comprising perennial species of high productivity. An oat of great vegetative vigour bred at the Station is promising for the first of these stages and a pasture strain of timothy (the time of development and maximum seasonal productivity of which coincides with that of wild white clover) has also been produced. This may be a useful variety for the second stage of pasture improvement. Seed stocks are to be obtained for field trials.

Agricultural Research Institute of Northern Ireland, Hillsborough, Co. Down. (1936-1938).

Full accounts of investigations carried out at the Institute appear usually in the Journal of the Ministry of Agriculture for Northern Ireland. The reports contain short notes of the work in progress under the section grassland investigations. (1) Comparison is made between ordinary permanent pasture mixtures and similar mixtures containing certain pedigree strains of grasses. (2) Small-scale perennial ryegrass strain trials have shown that the order of earliness in the strains tested was: Welsh S24, Commercial Irish, New Zealand Certified, Home Scot No. 50, Danish EF79 and Kentish Indigenous. Data on seed and hay yields will be obtained in 1938.

Experiments on the manuring of grassland are also made at the Institute. A trial started in 1935 was designed (1) to obtain information on the effect of N on yield of dry matter and protein from a permanent pasture, (2) to compare the effects of different rates of application of sulphate of ammonia, and (3) to compare results obtained with application of the fertilizer in two and three doses per annum. The fertilizer caused increased yields of dry matter and protein, and percentage of crude protein in the herbage was highest in the grass from plots receiving the highest application of sulphate of ammonia.

EIRE

Fifth and Sixth Annual Reports of the Minister for Agriculture. (1935-36 and 1936-37.)

During 1935 experimental sowings of four soybean varieties (Green Jap, Brown C, Yellow J and Black O) were made at eight centres. The seed (a portion of which was inoculated) was sown at the beginning of May in rows approximately 3 ft. apart. All the varieties germinated evenly and grew freely throughout the summer, although Yellow J and Black O were slow in maturing.

Sowings of the other two varieties have been made at the Cereal Station, Ballinacurra, the Munster Institute, Cork, and at the Agricultural Schools, Athenry and Clonakilty; further small-scale trials have been initiated at the Botanic Gardens, and in the counties of Dublin, Louth and Wexford by the respective agricultural instructors. The object of the principal experiments is to test the effects of sowing at different dates, under different conditons and of the application of manurial dressings. See *J. Dept. Agric., Eire, Herb. Abstr.* 9. No. 3. 1939, where it is maintained that the growing of soybeans under Eire conditions is not economic.

Agricultural Department of the University College, Dublin. (1935-36.)

(Appendix in the above publication.)

Results of work on intensive management of pastures which has been carried out over a period of eight years have been published. See Drew and Deasy, *Herb. Abstr.* 7. 289. 1937.

In collaboration with the Departments of Agricultural Chemistry and Animal Nutrition, investigations on grass silage (made from different cuts and ensiled by different methods) and losses in nutritive value resulting from the process have been made and results are to be published in the Journal of the Department of Agriculture.

Experiments on the cultivation of soybeans have yielded unsatisfactory results owing to unfavourable climatic conditions. In collaboration with the Plant Breeding Department, plots of pure seeding *Dactylis* (indigenous hay type and indigenous pasture type) have been laid down with a view to the production of seed of these strains. Varietal trials with cereals, grasses and clovers have been continued by the Plant Breeding Station. Trials laid down in 1934 with indigenous seeds of perennial ryegrass, cocksfoot, with certified seed of these species, and of red and white clover from New Zealand were completed. The New Zealand seed of the grasses started growth earlier than the indigenous strains, but the latter produced heavier yields at harvest. There was little difference between New Zealand Montgomery red clover and the indigenous strain of the same species. The New Zealand certified white clover differed from Kentish white in habit and vigour of growth, although the former stocks proved to be persistent.

Trials laid down in 1935 to compare indigenous perennial ryegrass, perennial ryegrass from the Welsh Plant Breeding Station and two strains of indigenous cocksfoot are being continued for another year.

The Section of Agricultural Botany has investigated yields from seed mixtures. In the spring of 1936 arrangements were made with the Department of Agriculture for the establishment of trials with selected seeds mixtures in different counties.

Satisfactory establishments of lucerne were obtained on College Farm plots. The seed was broadcast in autumn on wheat stubble with *Trifolium incarnatum* as a cover crop in one trial and with *Lolium westerwoldicum* in another. It is concluded that lucerne can probably be grown on most Irish arable land at low altitudes. Seed should be inoculated and lime and good drainage are essential.

Albert Agricultural College Farm, Glasnevin. (1936.)

Experiments in vernalization have been made with winter wheat, barley, maize and soybeans at the above farm. Wheat development was slightly accelerated by the treatment but no effect was produced on development of the other plants. Germination was adversely affected in the maize and soybean varieties used.

GERMANY

Biological Institute, Berlin-Dahlem. (1937).

A full report on the work in 1937 of the Institute (Biologische Reichsanstalt für Land- und Forstwirtschaft, Berlin-Dahlem) and of its Branches is presented by the President, Dr. E. Riehm, in *Landw. Jb.* 87. 567-720. 1939. The following research is of interest in connexion with forage crop production.

Plant Protection Division. Diseases of *Lupinus* have been studied by H. Richter, as follows. (1) Foot rot. Various causal agents are responsible, and the disease

is obviously dependent on environmental conditions (weather and soil). *Fusarium* spp., *Rhizoctonia solani* K., and *Thielavia basicola* (B. et Br.) Zopf can all be concerned in foot rot. *Lupinus albus* is most susceptible, followed by *L. angustifolius* and finally *L. luteus*. (2) Wilt, produced by *Fusarium oxysporum* Schl. and, as far as present information shows, confined to *Lupinus luteus*. (3) and (4) A disease producing defoliation and caused by *Macrosporium sarcinaeforme* Cav., and brown spot caused by *Ceratophorum setosum* Kirchn. [see *Herb. Abstr.* 8. Abs. 407. 1938.]

Botanical Division. Special studies of forage plants are being made at the Institute's Branch Station at Königsberg, East Prussia, which was founded in 1932 to serve the eastern provinces of Germany and to study in particular forage crop production under the prevalent conditions of cold winters, light soils, short growth period and low rainfall. An outline is given of work by A. Hey in this connexion. It has been found that the time at which sowing is done is practically all-important in reducing risk, and that suitable tillage, also, is imperative. The following are some of the conclusions in regard to optimal time of sowing in the regions concerned: *Ornithopus*, broadcast, second half of June; *Medicago*, beginning of March to middle of April and July; *Trifolium pratense*, *T. repens*, *T. hybridum*, *Lotus corniculatus* and *Medicago lupulina*, February and March; crimson clover-vetch-ryegrass mixture, beginning of August to middle of September; *Vicia villosa*, March to April; *V. pannonica*, October.

Other work at the Königsberg Branch included investigations on anthracnose of *Ornithopus sativus* [see Hey, Klinkowski and Richter, *Herb. Abstr.* 7. 182. 1937]; studies by J. Stephan of *Ornithopus sativus* [see Stephan, *Herb. Abstr.* 7. 220 (two articles). 1937]; lucerne trials in charge of W. Schoel, with special reference to conditions in East Prussia; experiments by A. Hey in the growing of various combinations of legumes; and studies by Schoel and Stephan respectively of plants to be grown as supports for vetch (*V. sativa* and *V. villosa*) and *Ornithopus*.

Among physiological studies conducted by the Botanical Division at Berlin-Dahlem, K. Heinze established in infection experiments that *Doralis rhamni* transmits *Cucumis Virus* 1 to *Lupinus angustifolius* (alkaloid-free), and it is likely that other aphids also are vectors. The virus probably hibernates not in the insect, but in hardy, intermediate host plants, a list of which is given.

A study of *Ornithopus* spp., wild and cultivated, in Spanish Morocco and the Iberian peninsula was made in the summer of 1937 by M. Klinkowski [see *Herb. Abstr.* 8. Abs. 551. 1938.]

Variety trials included a morphological study of 308 varieties of roots (fodder and sugar beet, kohlrabi, and turnips) by K. Ludewig, and a study of the morphology of forty-two varieties of field peas and of twenty-four varieties of field beans, by the same worker. At the same time degree of liability to attack by pests was studied in the pulse plants. J. Voss studied thirty-seven fodder and sugar beet varieties for tendency to bolt.

Work of the Division for Agricultural Zoology included studies of the development and control of *Melolontha* spp. by H. Thiem and E. Pattri; and, in the Division for Microbiological Chemistry, bacterial stem disease of *Pisum*, caused by *Pseudomonas pisi*, was studied by C. Stapp, and *Fusarium*-produced diseases of *Cajanus indicus* [see *Herb. Abstr.* 8. Abs. 1610. 1938] by H. W. Wollenweber.

Studies concerned with Agricultural Chemistry and Soil Science included investigations by E. Pfeil and M. Klinkowski on the alkaloid content of *Lupinus* as affected by potassium deficiency [see *Herb. Abstr.* 8. Abs. 1384, 1938], wherein it was found that an inadequate supply or an absence of K produces an increase in the plant's content of alkaloids, a certain parallel existing between the percentage alkaloid increase and the fall in the amount of K available. Another study, by E.

Pfeil and C. Stapp, was concerned with the metabolism of tumours produced in *Beta* by *Pseudomonas tumefaciens*, wherein distinct and sometimes considerable differences were found in the reaction, and the nitrogen, sugar and ash content of diseased and sound tissue respectively.

The branch Station at Kitzeberg, Kiel, is concerned with the study of diseases and pests of forage crop plants, among others. The following investigations were carried out in the year under review. (i) Study of the biology of the lucerne weevil, *Phytonomus variabilis* Hbst., by O. Kaufmann, with special reference to its dependence on temperature and moisture, and to its parasites. This weevil, of no economic importance in Germany before 1922, has become a serious menace to lucerne cultivation of late years. The life cycle is briefly outlined. *Bathyplectes curculionis* is found to be the most important parasite. (ii) Study of a virus disease of turnips, by O. Kaufmann. This disease, first recorded in 1934, became more widely distributed in 1937 and in that year caused the greatest amount of damage it has yet produced. *Lygus pratensis*, which transmits the virus, has been subjected to study. Whether aphids or other sucking insects are also vectors has not yet been established, nor has any explanation been found of the fact that late sowings are less seriously attacked by the disease. (iii) Study of clover rot produced by *Sclerotinia Trifoliorum* Erikss., H. Pape. Experiments in the cleaning of clover seed by an electro-magnetic process (described) were practically 100 per cent successful. A trial of artificially infected clover varieties demonstrated the greater resistance of indigenous varieties and the greater susceptibility of foreign, especially southern, varieties. Sclerotia buried 25 cm. deep in 1929 were found to be still 88 per cent alive in 1937, that is to say, seven and a half years later. Winter peas (*Pisum*) were found to be heavily attacked by *Sclerotinia Trifoliorum* in the spring, and a dying back of *Vicia villosa* and *V. pannonica* simultaneously observed also appeared to be attributable to the same cause : investigations are still in progress.

At the branch Station at Gliesmarode, Brunswick, special studies of winter hardiness were made by H. Rabien, herbage plants and legumes such as peas, vetch, and sweet lupins being included in the material.

The Guhrau Station in Silesia is particularly concerned with diseases and pests of root crops. In 1937, *Piesma quadratum* Fieb., the insect vector of leaf curl in beet, was the subject of investigations by G. Nitsche and H. Förster. The biology of the insect, methods of destroying it, and methods of growing virus-free beets for planting out were studied. The chief aim of the work is the evolution of a method of selecting a virus-resistant beet. Heart rot and dry rot of beet were studied by G. Nitsche and W. Kosswig. Suitably timed treatment with boron was found to be a preventive, and, when the dose of boron was not unduly heavy, no ill effects were produced on succeeding crops.

The work of the Aschersleben Branch Station consists of research on diseases and insect pests of vegetables. Studies of the development and control of *Laspeyresia nigricana* Steph., by Langenbuch and Koerting, showed that tall varieties of *Pisum* are more seriously attacked by this insect than are the shorter varieties, and early flowering varieties which bloom for a short time only are less liable to attack.

Institute for Soil Science and Crop Production, Bonn

In a pamphlet published in 1938, pp. 27, Professor Klapp, Director of the Institute for Soil Science and Crop Production at the University of Bonn (Institut für Boden- und Pflanzenbaulehre), gives a brief description of the three farms on which—in addition to the 4.6 hectare field near the Institute itself—experimental work is conducted.

Dikopshof (123 hectares, situated in the Rhine lowlands between Bonn and Cologne, rainfall 600 mm.) is devoted to work with various crops, including clover, lucerne, and forage mixtures, and to seed reproduction, educational work, etc. Marhof, also in the lowlying Rhine valley, is occupied with horticultural studies. Of particular interest is the 75 hectare Rengen estate in the Eifel, altitude 450 to 500 m., rainfall 650 to 850 mm., dry periods—if not drought—usual in summer. Until 1930 Rengen was waste land, but was taken over by the Prussian Ministry of Agriculture of that time and converted by the Bonn Institute into good grassland [see T. Remy, *Herb. Abstr.* 4. 27. 1934, and 5. 195. 1935]. A diagrammatic synopsis of the work done here from 1930 to 1938 is given on p. 19 of Professor Klapp's report. Untouched waste land has been reduced from 39.5 to 5.8 hectares. The estate is used to-day for further experimental work on the reclamation and utilization of waste land, and for the grazing of some of the Dikopshof stock and the provision of some of the fodder for Dikopshof.

Prussian Moorland Experiment Station, Bremen. (1937.)

The report for 1937 is presented by Dr. Bruene, the Director, in *Landw. Jb.* 87. 521-63. 1939.

Grassland experiments in progress on the Königsmoor Experiment Farm, where rainfall in 1937 was 827 mm., or 177 mm. more than the average from 1913 to 1932, comprised a large number of long-duration liming and manurial trials and also the following.

(a) On hay land. Drainage by means of ditches of varying depth (twenty-third year of experiment). Rolling of drained high moor (eighth year of experiment, the value of rolling being clearly demonstrated). The utilization of high moor meadows for both haying and grazing (fourth year of experiment). Comparison of the effect upon yield (high moor) of the habitual use of mowing machine and scythe respectively (fifth year). Comparison of different forms of preparation for new sowings (sowing was done in 1935, after fallow in some cases, after different crops in others, and after various types of manurial treatment). The mulching of high moor meadow with potato tops (second year of experiment; the effect was to reduce yield). Effect of different varieties of *Trifolium repens* on hay yield, with KP as the only fertilizer (in progress since 1935; Ladino and Morsö superior to a Holstein variety). Of the manurial trials, an experiment in the application of N to old high moor meadow, in its eighth year, gave similar results as in previous years (see *Herb. Rev.* 4. 162. 1936), increased yield only being obtained by the combination of compost with N, N alone giving a lower yield than KP, and the crude protein content of the hay on the N plots being lower than that of the other plots.

(b) Pastures. Comparison of permanent pasture and rotational grazing for fattening steers (eighth year: rotational grazing gave a live weight increase of 33 kg. per hectare more than on the permanent pasture in 1937, but on an average for the years 1930-36 only 0.9 kg. more). Comparison of annual and biennial (double dose) applications of KP (seventh year: result of annual dressings superior). A pasture sown down in 1914, marled in 1929, continues to exhibit greater productivity on the marled portion (greater live weight increase in 1937, 119 kg. per hectare; average greater increase for 1934-37, 112.4 kg. per hectare: carrying capacity, four steers per 1.52 hectare marled pasture as against three steers on the control).

Experiments on the Widdelswehr marshland Experiment Farm (rainfall in 1937 greater than the average for 1925-34) included trials of *Medicago lupulina* as a green manure on arable land. Grass seed production also took place, one field each of *Festuca pratensis* and *Bromus inermis* being in 1937 in their second harvest year.

Yield was 468 and 157 kg. per hectare respectively. A pulse-oats mixture was grown for ensilage purposes, and a winter hardy mixture of *Lolium italicum* (25 kg. per hectare), *Trifolium incarnatum* (25 kg.) and *Vicia villosa* (38 kg.), sown in 1936, yielded 217 dz. green weight per hectare in June, 1937. A trial of Rapko was unsatisfactory. An experiment in the application of N to dairy pastures was laid down in 1937.

In addition to the above-mentioned experiments, a very large amount of experimental work in charge of Dr. C. Husemann, much of it grassland improvement, is being conducted by the Bremen Institute on moor, heath, and marsh land in many parts of North Germany, and much consultative and educational work is also being done.

For a review of the Station's report on the two previous years' work, wherein some of the above-mentioned experiments are described in more detail, see *Herb. Rev.* 4. 160-2. 1936.

Institute for Forage Crop Production, Dairy Research Station, Kiel. (1937.)

The Institute's report for 1937, by the Director, Prof. Dr. W. Nicolaisen, appears in *Landw. Jb.* 87. 463-8. 1939.

Plant breeding. Work on herbage and forage plants, at the Institute's Steenbek Gardens and elsewhere in the province, was considerably extended in 1937. Material included some which had been brought back by the Hindu Kush Expedition. Special attention was paid to the question of increasing protein content while at the same time maintaining or even improving other valuable characters, and to breeding for immunity, with special reference—in the case of herbage plants—to *Sclerotinia Trifoliorum*.

Trials and studies of cultural technique included trials of protein plants for their value under the regional conditions ; a study of the cropping value of different plants as the principal crop and for secondary crops respectively ; studies of marrow stem kale, which is found to be of great value for the north-west of Germany, and of the hybrid Rapko ; and a study of the effect of the time of mowing upon the yield and composition of the Landesberg mixture [see Nicolaisen and Seelbach, *Herb. Abstr.* 8. Abs. 150. 1938].

Sweet lupins were found to be an invaluable source of protein fodder both on the light heath lands, where they are a good substitute for poor temporary leys, and as a catch crop on the heavier moraine soils.

Experiments in the utilization of potato and turnip tops proved the value of the former as a source of fodder in emergencies.

Cover crops were found to have a bad effect upon lucerne sowings, varying in degree according to the species employed as cover and to the seeding rate ; ordinary clover was much less seriously affected, and the botanical composition of clover-grass mixtures was found to change in accordance with the cover crop used. Experiments in the growing of lucerne together with red clover and grasses were extended.

Experiments in the application of copper sulphate in regions where animals have suffered from pica gave successful results [see Nicolaisen and Seelbach, *Herb. Abstr.* 8. Abs. 1233. 1938].

Long-duration manurial trials, begun in 1935, were continued on heath and high moor land, wherein alterations in botanical composition were observed. Results are not yet published. The manurial treatment of catch crops has also been the subject of experimentation.

Several trials of maize for its value under Schleswig-Holstein conditions were in progress, and investigations on cultural and harvesting technique were made.

A special study was made of the productivity and botanical composition of grassland reclaimed from flooding by the North Sea, with a view to determining the effect of damming and of the various methods of improvement.

Phytopathological Institute, Landsberg on the Warthe. (1936-7.)

The report for 1936-37 is presented by the Director, Dr. G. O. Appel, in *Landw. Jb.* 87. 398-406. 1939. Work has been in the main connected with potato diseases. *Ustilago zeae* in maize has also been studied. The work of a plant protection office and seed testing station is carried out by the Institute.

Plant Breeding Institute, Landsberg on the Warthe. (1936-7.)

The report for 1936-37, presented by Dr. W. Heuser and collaborators (*Landw. Jb.* 87. 413-20. 1939), describes work on the following, among other crop plants.

Helianthus annuus. The aim here, which was the production of an indigenous variety combining single-headedness, earliness, and uniformity, has been practically achieved, and further objectives—oil content, ratio of kernel to shell, and yield—are now being sought. [See also Heuser, *Herb. Abstr.* 7. 115. 1937, and 8. Abs. 1175. 1938.]

Vicia Faba and *V. narbonnensis*. Results of trials during the period under review were not encouraging, the continental climate of the locality rendering these crops very unreliable.

Trials were made of *Pisum* in mixed sowings (a practice found not to increase productivity, but merely to facilitate cultivation and harvesting), and in variety trials (Peragis field pea pre-eminent both for grain yield and for green weight).

Lupinus. It was found that the blue sweet lupin and the yellow sweet lupin—in contrast to the blue bitter lupin—grow most successfully when sown early. *L. albus* was found to give much better yield than *L. angustifolius* and *L. luteus*, a Portuguese variety of *L. albus* yielding 18 dz. more grain per hectare than a blue and a yellow lupin in the dry summer of 1937. Trials of *L. albus* varieties were continued, and studies of sowing technique were made and reported in the press [see Heuser and others, *Herb. Abstr.* 7. 112. 1937].

Vicia and *Lathyrus*. A trial of vetch varieties, begun in 1935 with nine, was continued and enlarged, so that twenty varieties were under observation in 1937. Of *Lathyrus* three strains of *L. sativus* were studied, in comparison with *L. magellanicus*, *L. clymenum* and *L. tingitanus* and several other legumes also (field peas and beans, and *Lupinus albus* and *L. luteus*). The termination of this trial was fixed for 1938, when results were to be summarized. Twenty forms of *Lathyrus* were selected from a collection of seventy received from the Hindu Kush Expedition in 1936, and were studied for their cultural value.

Rape and roots. Variety trials demonstrated the superiority of certain German varieties. Cultural and sowing technique were studied.

Vicia villosa and *V. pannonica*. Seeds were tested by a process designed to make the seed-coat hard, whereby different degrees of susceptibility to the treatment became apparent, and the selection of individuals and study of the descendants showed this character to be inherited. The technique for testing tendency to hardness of seed-coat has been described [see Huebner, *Herb. Abstr.* 8. Abs. 1171. 1938].

Medicago. Methods of employing one and the same sowing in testing varieties both for grain yield and yield of green weight have been evolved and described [see Huebner, *Herb. Abstr.* 7. 212. 1937].

Trifolium spp. In *T. repens* and *T. hybridum* breeding for bulk and dark leaf

colour was continued with success. A selection of *T. pratense* was begun, the objective being the production of a very vigorous annual, for autumn use solely.

Grasses. In the breeding of *Bromus inermis* a positive correlation between leaf colour and protein content was established. Forms distinguished by good bulk exhibited low seed yield; good seed-bearing forms were deficient in green weight production. [See Huebner, *Herb. Abstr.* 8. Abs. 499. 1938.]

The breeding of *Avena flavescens* was newly taken up in 1937.

Grassland Institute, Landsberg on the Warthe. (1936-7.)

The report for 1936-37 of the Grassland Institute at Landsberg on the Warthe, Prussia, is presented by Prof. Dr. A. Koenekamp, Director of the Grassland Institute, in *Landw. Jb.* 87. 383-426. 1939. An account is given of the following experiments.

(1) *Lysimeter experiments* for the determination of water consumption by catch crops were conducted by H. Unglaub as follows: Landsberg mixture (*Trifolium incarnatum, Lolium italicum, Vicia villosa*), sown August, followed in the succeeding year by potatoes, sown June; fallow, September to May, followed by potatoes, sown end of May; control, no plants. Watering and other conditions were uniform. Water consumption from September, 1936, to October, 1937, was, in mm., for the mixture and potatoes respectively 273 and 266, together 539; for the fallow and potatoes respectively, 183 and 342, together 525. In the fallow series the yield of potatoes was greater, to a degree varying in accordance with variety. The yield of the mixture amounted to 230 dz. per hectare.

(2) *Sowing trial* (H. Unglaub). Comparison was made of twenty-two different times of sowing (April 1 to June 30, and August 10 to October 20) of five grasses, alone and in a mixture. Soil (humus-deficient loamy sand) and water table (lower than 10 m.) were unfavourable for grass. Results are as yet incomplete, but it was found that root development and closeness of sward were of great importance for productivity, and that these again were chiefly influenced by the weather during the initial development of the grasses and during the winter, and by the time at which the first deep cut was taken. Hay and crude protein yields in 1936 and 1937 are tabulated. In an inland climate such as that of Landsberg (Warthe), summer sowings (August and beginning of September) proved most successful. [Unglaub. *Herb. Abstr.* 8. Abs. 1999. 1938.]

(3) Further *lysimeter trials*, in charge of H. Unglaub, were carried out to determine water consumption by catch crops; and the same worker conducted also pot trials of Mahndorf timothy (*Phleum pratense*) grown in earth with four different water levels (0.40 to 1.20 m.); studies of *root development* in grass varieties, which are to be followed by studies of rooting in sweet lupin stands and in varieties of *Vicia Faba* and *Ornithopus*; pot trials to test the effect of K_2O, P_2O_5 and CaO on the development of *Trifolium repens* and to determine the water consumption of *Lolium westerwoldicum* under different doses of K_2O and N; and pot trials of different legume species grown successively and to be studied for their effect upon each other's development. The last-named trials are being supplemented by two trials in the field.

(4) *Soybean* variety trials, 1931-35 (report by Benkert). Trials of sixteen varieties, studied for their utility as ensilage plants, showed that Prof. Riede's Bonn bred strains occupy a place apart in their value both for ensilage and also for grain yield [see Koenekamp, *Herb. Abstr.* 8. Abs. 1155. 1938].

(5) *Kohlrabi* variety trial, 1935-37 (report by Benkert). A trial of fifteen varieties, including the English "Crimson King," showed German indigenous to be in general superior to foreign varieties. It is probable that for the latter Landsberg conditions, especially air humidity, are unsuitable. In judging the varieties, palatability was taken into account.

(6) Current field trials (report by Benkert). A large number of these were in progress during the year under review, and comprised the following : variety trials of sugar beet, marrow stem kale, maize, fodder carrots, horse beans, sunflowers and sorghum varieties. Trials of graded sowings and experiments with different catch crops were further developed. In addition to experiments in winter catch crops, crop rotation experiments, begun in the previous year, were continued and utilized particularly for the study of water relations and the uptake of nutrients in catch crop cultivation. Experiments with lucerne and clover-grass mixtures were continued and were amplified by special investigations on the growing of lucerne in river lowlands, which have led to valuable conclusions [see Koenekamp, *Herb. Abstr.* 8. Abs. 1141. 1938]. An experiment in the grazing of lucerne was continued. Another grazing trial was concerned with tests of palatability in *Poa pratensis* and *Lolium perenne* under different forms of mineral fertilizer. A comparison of the growing of pure sowings and mixtures of different grasses (*Avena elatior*, *Festuca pratensis*, *Dactylis glomerata*, *Poa pratensis*, *Lolium perenne* and *Bromus inermis*) was in progress for the second year, and a trial of various lawn mixtures, including several from England, was inaugurated.

(7) *Grassland improvement in the Lower Oder Basin.* A report on this work is presented by G. Mueller from the base of operations at Greifenhagen [see the following and previous reports].

(8) Model areas in the *Netze Marsh* and the *Warthe Marsh* (report by Schedensack). There are sixty of these areas, varying in degree of moisture, each 0.5 hectares in size, situated in different parts of the localities named, and some of them in existence since 1932. They are studied for hay yield and botanical analyses are made, the principal aim being to see how long, under the various soil and moisture conditions represented in the different areas, meadows can give satisfactory yield without ploughing and resowing. It has been found that with suitable seeds mixtures highly productive meadows can be obtained, which do not show the customary signs of deterioration from the third year onwards if mixtures suitable to the locality and proper manurial treatment are employed. Nevertheless, it is considered that in the drier localities it would be better to convert the meadows into arable land.

Grassland Improvement in the Lower Oder Basin. (1937.)

The fifth report on this work is now published (Koenekamp, A., Mueller, G., and Siegert, R. Tätigkeitsbericht 1937 über die Versuche zur Verbesserung der Wiesen an der unteren Oder. Landsberg (Warthe). 1938. pp. 48). The fourth report was reviewed in *Herb. Rev.* 6. 210-1. 1938. During the fifth year's work in 1937 not only have the previous experiments been continued, but they have been considerably enlarged and reduplicated. The work is centralized at Greifenhagen and Fiddichow (on the Oder), and data are presented on monthly precipitation and the mean monthly water level (April to September) in these localities for 1937. The following groups of experiments are described.

(a) *Manurial deficiency experiments.* Two of these have been in progress since 1933. Hay and crude protein yield and the botanical composition in the respective years are tabulated and discussed. It is found that profitable increase in the yield and quality of meadow hay may be obtained through manurial treatment alone, especially N, on poor clay and mud soils with sufficient moisture ; but on lowlying, excessively wet land, sedges remain dominant even under heavy manuring, and not until drainage and therewith movement of the ground water have been carried out is the soil in a fit condition for the growth of good grasses. A new experiment was laid down in 1937 on land which has been under improvement since 1934, and although no conclusive deductions can be made from the first year's results,

full manuring has been found most effective in increasing yield, and full manuring and manuring with potassium produced an increase in the proportion of good grasses and a reduction in that of sedges and weeds.

(b) *Grass variety trials.* Two trials, in progress since 1933 and 1934 respectively, for the testing of different species and varieties grown singly and together, have been continued. The behaviour of the different grasses under diverse conditions is described. Especially striking was the difference in average annual hay yield (1934-37) in the two experiments as affected by water movement. In the case of one experiment artificial movement of the soil water through pumping had produced water tables fluctuating between 25 and 70 cm., in the other the water table was stationary, from 8 to 35 cm. In the former case average yield was extraordinarily high, approximately 127 dz. per hectare for pure cultures and 121 dz. per hectare for mixtures; in the experiment with stationary water table the corresponding figures were 88 dz. per hectare and 93 dz. per hectare. The yield of legumes on the pumped land was also greater.

(c) *Trials of mixtures for temporary leys.* Average yield and botanical composition of the stands, 1934 and onwards, are reported and discussed in relation to manurial treatment, soil preparation and sowing technique.

(d) *Pasture trial on winter-flooded land.* A review of results obtained from different treatments, 1933 and onwards, is presented. The experiment has been in general satisfactory. *Trifolium repens* has suffered from the annual flooding, long every year and especially so in 1937, but grazing has resulted in an improvement of the sward through the increased proportion of bottom grasses and a great reduction in that of *Ranunculus repens*, the principal weed. Weeds have been reduced from 7 and 44 per cent in 1935 to 1 and 3 per cent in 1937. The total productivity of the pasture in the year under review was approximately three times that of 1933 and would have been still greater but for an interruption of grazing (12 to 30 July) due to an epidemic. The cost of production per kg. starch equivalent, which was 15.7 to 19.9 Rpfg. in 1933, was only 3.5 to 3.7 Rpfg. in 1937.

(e) *Experiments in the regulation and movement of soil water* through pumping have been continued, and confirm previous findings on the importance of these measures for aerating the subsoil and increasing the O_2 content of the water in land with a high water table and imperfect natural drainage. Part of the land used for these experiments was occupied by hay crops: yield increased from 63.5 dz. per hectare in 1934 to 164.8 in 1937, the corresponding figures for crude protein yield being 7.33 and 14.35. Botanical analyses establish an equally important improvement in the composition of the hay. Development in pure sowings of grasses and in an area used first for roots, tubers and fodder mixtures, and sown down to hay in 1937, was satisfactory also. The proportion of *Trifolium hybridum* and *T. repens* only was reduced in consequence of flooding.

(f) *Improvement by tearing, reseeding and manuring.* Two different mixtures were used in two experiments. Data on yield, botanical composition and weed reduction are presented. Yield was greater by 7.3 dz. hay and 1.1 dz. crude protein per hectare when tractor-drawn tearing implements were used instead of horse-drawn implements, a fact which is attributed to the greater speed with which the work is done by tractors.

(g) *Model plots.* Yield in 1937 ranged from 70 to 119 dz. per hectare in the meadow hay plots. Development of a *Vicia villosa-Lolium* (var. *Oldenburgiensis*) mixture sown in the autumn of 1937 was good.

Prussian Experiment Station for Agricultural Labour, Bornim, Potsdam. (1936-7).

The Station's principal activity is the study of labour-saving methods and

equipment. In the report for 1936-37, presented by the Director, Dr. L. W. Ries, in *Landw. Jb.* 87. 427-33. 1939, an interesting method of curing hay is described.

In many parts of Germany where small holders' farms are general, it is customary to make hay that is ready to carry within two days. Careful experiments have shown that this method of haymaking may be carried out under almost any circumstances, provided every possible means of accelerating drying is fully utilized. The grass is mown in the early morning hours and at once shaken up. Continuous turning with suitable machines and implements hastens the drying of the grass to such a degree that it is possible to carry the hay on the afternoon of the second day. Through mechanization of the different processes the labour entailed in haymaking by this method is considerably less than it is under the usual methods. When machines that do not handle the hay roughly are employed, mechanical losses —in spite of intensive working—are reduced to a minimum. The hay thus cured is distinguished by especially good colour, excellent smell and high fodder value. The process is one which can be employed on any farm.

NETHERLANDS

State Agricultural Station, Groningen. (1938.)

The first two parts of the Station's Report for 1938 [Verslag van het Rijkslandbouwproefstation voor den Akker- en Weidebouw te Groningen over 1938. 's-Gravenhage, 1939. pp. 53] deal with soil studies and with manurial and plant nutrition studies respectively. Three trials, each having 144 plots, were concerned with the time at which nitrogen is applied to grassland in the spring, studied in conjunction with the effects of mowing at different times. In another trial farmyard manure was applied in 1937 to six different grassland areas, each comprising eighty plots; and the results as yet perceptible show the effect in the second year to have been extremely insignificant, and indicate that, when convenient, it is preferable to apply farmyard manure in July or August. Other manurial trials were concerned with the application of PK in spring and summer (spring dressings considered best); and the value of different forms of phosphates on grassland. Seventy-six grassland areas were studied for the relation between the nature of the soil and the reaction of the plant to phosphates. Four grassland liming experiments are at present in abeyance, but are to be studied later for the degree to which the lime has penetrated the soil; and in other liming trials the penetration of five different forms of lime, and of three different quantities of marl used with and without farmyard manure is being studied.

The third part of the Report, which deals with cultural technique and problems connected therewith, includes notes on the following work. In a pot trial (seventy-two pots) the effect of the water table on the yield and botanical composition of grassland was studied, wherein there were tested four different water tables, three types of soil, two quantities of nitrogen and three forms of management (simulating grazing and haying). A ten-year study of the effect upon grassland of drawing off water for a conduit is still in progress: a plot is kept under constant observation, in comparison with a non-affected control plot. Various forms of improving the grassland cover of the inner slope of a sea dike are being tested, results up to the present giving the impression that full manuring in conjunction with the sowing of a mixture is the most successful. The experiment is to continue for several more years. Of special interest is a review of the various types of grassland represented in the Netherlands, begun in 1938, and, it is hoped, to be completed in 1939, wherein

soil, rooting, and botanical composition in representative areas in all parts of the country are studied and correlated. This work is being done in collaboration with the Government Agricultural Advisors (Rijkslandbouwconsulenten). Grazing technique and pasture management were the subject of special study at the Experiment Farm, Burum, and haymaking problems—previous grazing, time of mowing, frame-drying etc.—were also studied there. Experiments in rotational grazing all the season round show an increase in grazing days and milk yield of approximately 20 per cent. The effect of nitrogenous fertilizers and the distribution of grass growth over the season is also improved by this method. Studies of root growth in various plants were continued. In an experiment in the vernalization of rape, begun in 1937, no perceptible effect from the treatment could be recorded, and the experiment was terminated. The resistance to frost of seventy-five wheat varieties was studied by means of an artificial freezing method : a close relation between high degree of resistance to cold and early shooting was determined. The effects of depth of sowing, date of sowing and manuring with varying quantities of nitrogen and potassium were also studied. An attempt made to induce earlier flowering in twenty-seven varieties of maize by means of short-day treatment (a ten-hour day for four weeks) resulted in development being on the whole hastened, but only to a slight degree, while the short-day plants in every variety were poorer than the control. Short-day treatment combined with a temperature of approximately 30°C. enfeebled the plants to such an extent that growth was almost entirely inhibited. Some vernalization experiments with small samples of wheat were initiated. Studies were made of different legume inoculants, and cultures were prepared for distribution. Some questions concerning green manuring were studied, and different fodder plants were tried for their value in the Netherlands. These included maize, soybeans, and the fodder mallow. Although there have been found soybean varieties which will ripen early in Holland, yield is too poor for their cultivation to be worth while, but it is considered possible that, through importing or breeding, soybean growing might be facilitated. *Malva* was found to grow rapidly in the heavier soils and to offer some promise as a catch crop. It yields a large quantity of seed.

In the fourth part of the Report, which deals with studies of quality, composition, conservation, etc., it is noted that 329 grass samples were botanically analysed. Methods of analysis are discussed. Studies on the artificial drying of grass were continued.

Appended to the Report is a list of publications by members of the Staff of the Station.

Government Seed Control Station, Wageningen. (1936-1938.)

The reports for 1936-37 and 1937-38* respectively show that herbage seed forms a large proportion of the seed sent in for analysis (*Trifolium pratense*, 188 and 215 samples ; *Lolium perenne*, 139 and 155 samples). Data on the percentage of purity, germination capacity and sowing value are presented. In red clover, South European seed was found in one out of fifty-six, and three out of sixty-two samples only. Seed studied for water content included Western Wolds ryegrass (average 18 and 16.8), lupins (19.9 and 19.2), *Lolium italicum* (18.4 and 15.1), *Lolium perenne* (18.4 and 17.3), *Festuca pratensis* (18.2 and 17.7), *F. rubra* (17 in 1937-38), vetch (19.5 in 1937-38). Detailed information is given concerning the percentage and nature of adulterants found in the seed of certain grass and legume species. Of the total number of grass samples studied for purity (408 and 506 respectively), three in each year were found

*Kort Verslag van het Rijksproefstation voor Zaadcontrôle te Wageningen. 's-Gravenhage, 1937 and 1938.

to consist exclusively of another species, and twenty-two and twenty-nine in each year to be mixed with another grass species to a more or less serious degree. Phytopathological examination revealed the presence of *Bruchus* in a very large proportion of the field bean samples and of *Oligotrophus alopecuri* (2 to 10 per cent) in all the *Alopecurus* samples. *Tilletia decipiens* is reported in one sample of *Agrostis alba*. In 1936-37 clovers, especially *Medicago lupulina*, were often found to be infected more or less seriously with *Phoma*; in 1937-38 *Fusarium* and *Macrosporium* were reported, but the infection was not severe, and could be controlled by treatment with chemicals. Five samples of lupins studied in 1936-37 were all infected with *Botrytis*, *Fusarium*, *Macrosporium* or with bacteria, often with two or three of the above-mentioned fungi at the same time. Disinfection improved the condition of the seed. The question of the extent to which seed infected with *Botrytis cinerea* is poisonous to stock could not be definitely answered. It is noted, however, that *Botrytis*-infected seed is lighter than healthy seed, and it is suggested that when lupin seed is to be fed to animals it should first be put into water, when the lighter, diseased grains float on the surface and can be removed.

The Station undertakes the sealing of grass and clover seed, inspected in the field and in the lot. The following quantities were sealed during the years under review :

	1936–37 kg.	1937–38 kg.
Grasses (registered pedigree strains)	14,966	12,229
,, (certified)	33,298	18,537
Trifolium pratense (old indigenous variety)	16,973	30,142
T. repens (old indigenous variety)	4,852	2,500
Lupinus (" Sweet lupin," registered alkaloid-free strain)	33,733	10,800

Phytopathological Service. (1936-7.)

The Report of the Phytopathological Service for 1936 (*Versl. PlZiekt. Dienst Wageningen*. No. 87. 1937. pp. 84. pls.) records unsuccessful results in the experimental use of carbon disulphide for controlling the larvae of different cockchafer spp. in grassland. Brown patch in golf greens was successfully treated with malachite green. Paris green was found successful in controlling the larvae of *Tipula* in a golf green at Zemelen, no rain worms being killed ; while the use of derris powder killed a very large number of rain worms, no dead larvae being found.

Medicago. Attack by *Peronospora trifoliorum* is reported from several places, and from one place the presence of larvae identified as those of *Phytonomus* (*Hypera*) *variabilis* Hbst.

Lupinus. A virus disease of lupins caused serious loss, especially among the new sweet blue and white lupins, in the Netherlands, as well as abroad. Reference is made to the description published by Dina Spierenburg (see *Herb. Abstr.* 7. 181. 1937), and symptoms are illustrated by photographs.

Vicia Faba. Nicotine was found to be the most effective control of *Aphis fabae* L. on beans. *Ascochyta* on vetch grown on an experimental farm did not appear to be seed-borne.

Zea Mays. Damage is recorded caused respectively by *Oscinis* (*Oscinella*) *frit* L., by eelworms in *Fusarium*-infected maize cobs, and by an unknown agent believed to be frost. The eelworms were identified by J. H. Schuurmans Stekhoven as belonging to two species, both new, namely, a *Neotylenchus* species and a *Pseud-*

aphelenchoides species, the latter genus also being new. The damage believed perhaps to have been caused by the severe night frost of May 31st to June 1st concerned plants in experiment fields at Groningen, up to 50 per cent of the plants being affected. The injury was to the leaves, which were still young and had somewhat the appearance of having been cropped, all at the same level.

The Report for 1937 (*Versl. PlZiekt. Dienst Wageningen.* No. 89. 1938, pp. 92. pls.) presents a brief description of distinctive characters and life cycle in *Melolontha melolontha*, *Rhizotrogus solstitialis* and *Phyllopertha horticola* L., a study of which has been made in connexion with the increased number of complaints received concerning injury due to the larvae of cockchafers in grassland and arable land alike. Means of control are being studied.

A leaf spot disease of *Festuca pratensis* in experiment plots was found to be caused by a fungus identified as *Helminthosporium inconspicuum* C. et Ell. Seed disinfection is recommended.

Pisum. A case of serious infection of the grain by *Sclerotinia libertiana* Fuck is recorded, a state of affairs which should be controlled by suitable crop rotation.

Beta. Diseases caused respectively by *Rhizoctonia violacea* Tul., *Heterodera Schachtii* Schmidt, and *Bacterium tumefaciens* Erw. Sm. et Towns are recorded. Up to the present injury caused by *Bacterium tumefaciens* to beet in the Netherlands has been observed on the roots only ; in 1937 injury to the leaves was recorded for the first time. An American *Cuscuta*, C. *gronovii* Willd., parasitic in America on asters and willows, was found on a few beets in one locality. Serious damage was caused in another locality by a species of *Lygus* ; spraying with 0.1 per cent nicotine and soap proved an effective control.

Clover. Leaf spot on clover from the Plant Breeding Institute was considered probably due to *Macrosporium sarcinaeforme* Cav. A new disease of *Medicago lupulina* (folding, whitening and wilting of the leaves) is probably due to the larvae of *Dasyneura jaapiana* Rübs.

Vicia. Cases of false mildew caused by *Peronospora viciae* De By. are reported. Control by spraying with a disinfectant containing copper is said to be effective, but is too costly and makes it impossible to use the crop for animals.

Zea Mays. The larvae of *Hydroecia micacea* Esp. (in young maize), *Lema cyanella* Payk. and of various beetles were the cause of injury in different places.

Vicia Faba. Larvae of gall midges and of an *Apion* species found in the stems of backward bean plants from Groningen are considered to be secondary symptoms of disease, as the roots were found to be infected by a species of *Fusarium*, while the fungus *Verticillium dahliae* Klab. was also present. Damage to beans from lightning is reported.

CONFERENCES

Botanical Institute, Academy of Sciences, Leningrad

In a "Review of the activity of scientific conferences (seminars) held at the Geobotanical Department of the Botanical Research Institute of the Academy of Sciences in U.S.S.R. in 1936 and 1937" (*Sovet. Bot.* No. 3. 1938. pp. 129-40), L. E. Rodin summarized thirty-six reports grouped under subjects for the sake of convenience. It is hoped that the reports read to subsequent meetings will also be reviewed in the same journal, which is published by the Institute.

A. Theoretical Problems of Geobotany

1. A. P. Šennikov (BIN) reporting on "Ecology, physiology and phytocoenology" (1937) presented his own understanding of the scope, contents and design of these branches of botany.

B. Geobotany and Industry

2. A. P. Šennikov and others presented a conjoint report on "The results of research of the Volga-Kama Expedition" (1936). Šennikov, the botanist in charge of the expedition, outlined the research items and achievements of the thirteen members of the expedition over a period of three years, when over 1,000 phytocoenoses were described in detail and a new classification of associations and types of vegetation compiled. A. M. Leontjev presented a general description of the Mologa-Sheksna flooded lands being surveyed, and a new scheme of ecological correlations which differs in many points from that proposed by Šennikov (1935). R. A. Dydina reported the results of stationary studies of the dynamics of coenses, their productivity, seasonal behaviour, fodder value, seed production and other aspects of immediate practical application. N. I. Temnoev attempted to forecast the changes in vegetation which might be expected as a consequence of dam construction and submergence of certain lands. The results of the expedition have been embodied in six volumes.

3. F. L. Zaprjagaev (Tajikistan Base of AN. SSSR, Stalinabad) reported (1937) on the "Arborescent and frutescent vegetation of Tajikistan and their improvement" and on the stationary study of some established forms with reference to local horticulture.

4. E. A. Galkina (BIN) reported on "The survey of the marshes of Karelia, the trend of their evolution and agricultural utilization as exemplified by the Uros Lake marshland" (1937), with special reference to the vigour of the overground parts of plants in the association as affected by the character and distribution of their roots and the rapidity of sphagnum growth, and the correlations between different types of vegetation. The marshlands are of common lacustrine origin, but after lowering of the erosion bases they developed independently. Preliminary, but reliable, data were secured on some of the essential problems of reclamation (author's summary in *Sovet. Bot.* No. 3. 1938).

5. M. A. Jurcovskiĭ (Biolog. Group at AN. SSSR. Moscow) in his report on "The fundamental principle of the system of intensive agriculture and the significance of phytocoenology thereto" (1937) drew particular attention to the theory of mixed sowings, in the compilation of which, with the present meagre knowledge of the biological, ecological and edaphic factors, it is thought to be advisable to imitate the structure of natural coenoses.

C. The History of Vegetation

6. D. K. Zerov (Inst. Bot. Ukrain. Acad. Sci., Kiev) reported on "The main features of the stratigraphy of the marshlands of Ukraine in relation to post-glacial changes in climate" (1936), which has been published by the Institute in 1938.

7. B. N. Gorodkov (BIN) presented a report on " The steppe problem of the arctic regions" (1936), which was repeated by him at a recent meeting on the relict flora of U.S.S.R.

8. E. M. Lavrenko's report " Concerning the history of vegetation of sandy terraces of the Bug-Don basin " (1936) has been published in two parts, " On the age of psammo-endemism in the south of the European part of U.S.S.R." (*Izv. Gos. Geograf. Obšč.* 68), and in the article " On the genesis of sphagnum marshes within the steppe zone in the basins of Bug, Dnieper and Don " (*Sovet. Bot.* 1936. No. 3).

D. Monograph on Vegetation

9. A. P. Šennikov (BIN) " Grassland vegetation of U.S.S.R. (1936).

10. E. M. Lavrenko (BIN) " The vegetation of the steppes of U.S.S.R." (1936).

11. A. V. Prozorovskiĭ (BIN) " The vegetation of semi-deserts and deserts of U.S.S.R." (1936).

These three reports were incorporated in a symposium entitled " Rastiteljnostj S.S.S.R." [The vegetation of U.S.S.R.] published by the Academy of Sciences of U.S.S.R. in 1938.

12. V. P. Maleev (BIN) " The vegetation of the Black Sea region (the Euxinian province of the Mediterranean region) and its significance in the origin of the vegetation of western Transcaucasus " (1937) published in *Trudy Bot. Inst. Akad. Nauk SSSR. Ser.* 3. No. 4. 1938.

13. B. P. Kolesnikov (Far-East Dept. AN. SSSR. Vladivostok) " The Far-Eastern *Chosenia macrolepis*, its biology and coenoses" (1936), published in *Trudy Daljne-Vostoč. Filial. Akad. Nauk SSSR. bot. ser.* 1938.

14. N. Ja Katz (State Univ. Moscow) " Phytocoenoses of the Caucasian Reserves in relation to combined properties of species" (1936), published in *Zemlevedenie*, 38. No. 3. 1936.

15. N. A. Minjaev (Polar-Alpine Bot. Gardens AN. SSSR. Kirovsk) " The synusial constitution of Empetreto-Vaccinieta series of the Hibiny massif" (1937) is being published by the Academy of Sciences.

16. N. I. Temnoev (BIN) " The formations of mountain-steppe shrubs in the southern Altai " (1937). (Author's summary, *Sovet. Bot.* 1938. No. 3).

17. L. E. Rodin (BIN) " Association of the vegetation in northern and transunguz Kara Kum" (1937), where thirty-five established associations form two types of vegetation, namely, Desertisuffruticeta and Desertisuffruticuleta ; the associations were classed under larger taxonomic units. Distribution of the associations is very peculiar and formed twelve association complexes which were divided into homogeneous complexes, the associations of which form a single topographical-ecological series and have a common origin, and heterogeneous complexes. (Author's summary, *Sovet. Bot.* 1938. No. 3.)

E. Regional Essays on Vegetation

18. E. A. Busch and N. A. Busch (BIN) " Botanical surveys in South-Osetia" (1936), published as " The vegetation of eastern South-Osetia and its dynamics," in *Trudy Soveta Izuč. proizvod. Sil AN. SSSR. Zakavkaz. ser.* No. 18. 1936.

19. A. G. Doluhanov (Georgian Dept. AN. SSSR. Tbilisi) " The forests of Zanguzer" (1936), published as a dissertation at the Academy of Sciences in 1936).

20. Ja. Ja. Vasiljev (Far-East Dept. AN. SSSR. Vladivostok) " The types of forest reserve at the Mountain-Taiga Station of the Far-East Department of the Academy of Sciences in U.S.S.R." (1936). (Author's summary, *Sovet. Bot.* No. 3. 1938.)

21. A. A. Kolakovskiĭ (BIPS, Georgian Dept. AN. SSSR. Suhumi). " The vegetation of the highlands of Abkhazia" (1936). The highlands are divided into lime and non-lime formations which differ conspicuously in botanical composition of the vertical belts and in elevation of the corresponding belts. Six types of vegetation were established, among which the subalpine type is particularly rich in associations.

22. A. K. Magakjian (Armenian Dept. AN. SSSR. Erevan). " The vegetation of Armenia" (1936). The richness of the vegetation is outstanding and could be traced to a dozen origins, the

influence of North-Iran flora prevailing. A new botanico-geographical division of Armenia was suggested and illustrated by a map of the vegetation compiled by the reporter.

23. A. V. Prozorovskiĭ (BIN) " The vegetation of the western parts of Ferghana, the basin of Soha and Isfara" (1936) in which, using the scheme suggested by Šennikov, the reporter distinguished three types of vegetation, including some thirty associations.

24. F. Ja. Levina (Pedagog. Inst. Kharkov) " The marshlands of Chernigov Polesie" (1937), published in *Bot. Ž. SSSR.* 22. 1938.

F. Stationary Investigations

25. A. P. Šennikov (BIN) "The problems of the Middle-Volga Geobotanical Station and its research in 1935 " (1936), in which the reporter gave a comparative description of the Volga flooded lands as found in 1920 and 1935. The report was published partly in " The Middle-Volga grasslands during a period of fifteen years" (*Sovet. Bot.* 1936. No. 6) by the reporter and partly by M. M. Golubeva in " Some data on the constitution and productivity of the lake vegetation," *Sovet. Bot.* 1936. No. 6.

26. O. S. Poljanskaja (BIN) " The phytometer method and experiments on its application at the Middle-Volga Geobotanical Station" (1936), published in *Sovet. Bot.* 1936. No. 6.

27. L. I. Sosnin (Caucasian State Reserves, Guzeripl) " Observations on the snow cover in 1935 on certain forest slopes at the Caucasian State Reserves" (1936), in which the reporter stressed the effect of snow cover on the vegetation and suggested urgent relevant research problems.

28. M. V. Markov (State Univ. Kazan) " The research at the Middle-Volga Geobotanical Station in 1936" (1936), which concerned chiefly climatic and edaphic studies and is being published in *Trudy Bot. Inst. Akad. Nauk SSSR. Ser.* 3. No. 4. 1938.

29. L. I. Sosnin (Caucasian State Reserves, Guzeripl) " On the state of botanical research at the Caucasian State Reserves" (1937).

G. Miscellaneous

30. Ja. Ja. Alekseev (Pedagog. Inst. Smolensk). " On the conditions of maple growth in the Western Region" (1936).

31. Ju. D. Kleopov (Inst. Bot. Ukrain. Acad. Sci., Kiev), demonstrated " The new geobotanical map of Ukraine" (1936), which was compiled conjointly with E. Lavrenko, F. Levina and P. Pogrebnjak ; the map has not yet been published.

32. N. F. Komarov (BIN) in his report " The agricultural activity of man as a factor determining the trend of development of steppe vegetation" (1936) emphasized the difference in the effect of hay and grazing on agrobotanical conditions of grassland. The frequency of *Stipa* spp. in associations does not yet indicate virgin land, as *S. Joannis* and *S. Lessingiana* persist under mowing and disappear under grazing ; *S. stenophylla*, on the contrary, disappears rapidly on mown lands owing to late seeding. The fodder value and true cover of vegetation are more persistent under grazing, but the diversity of species is reduced more rapidly with grazing than with haying. Cessation of mowing and grazing leads to the formation of a new association which resembles ruderal associations (Author's summary, *Sovet. Bot.* 1938. No. 3.)

33. L. A. Smirnov (Inst. of Plant Industry, Leningrad) investigating "The vegetation of northern anthills" (1936) found that the associations contained components distinct from the surrounding association, belonging in some instances to distant coenoses. This and other evidence suggest a conscious activity of ants in selection and adaptation of associations to their needs.

34. A. D. Fursaev (State Univ., Saratov) " The botanical geography of the flooded lands in lower reaches of Volga" (1937), supplemented with schemes and diagrams, revealed a certain regularity in floristic isolation of the flooded lands.

35. G. E. Schultz (Polar-Alpine Bot. Gardens AN. SSSR., Kirovsk) reporting on "Phytophenology and the problem of reconstruction of flora" (1937), emphasized that, when plants are

introduced for cultivation in northern countries, more attention must be paid to their seasonal periodicity, as the specific seasonal rhythm of the extreme north rendered some valuable plants useless and induced hypertrophy in reproduction and growth in others, such as *Diathus, Campanula, Phlox* and some Gramineae. (Author's summary, *Sovet. Bot.* No. 3. 1938.)

36. B. N. Ovčinnikov (BIN) in the report on " The organization and mehods of investigation of plant resources" outlined a universal technique for the field study of plant raw material, which was, however, considered to be undesirable in subsequent discussions during the meeting.

BIN = Botanical Research Institute at the Academy of Science in U.S.S.R. Leningrad.
BIPS = Bureau for Investigation of Industrial Potentialities.
AN. SSSR = Academy of Science in U.S.S.R. centred in Moscow.
The year in brackets following the title of the reports indicates the year when the report was read.
Some of the reports published in *Sovet. Bot., Trudy Bot. Inst. Akad. Nauk SSSR.*, and *Z. Inst. Bot. Akad. Nauk URSR.* have been dealt with in *Herbage Abstracts.*

New Zealand Grassland Association

The mimeographed publication containing the papers read at the Sixth Annual Conference held at Dunedin, August 10—12, 1937, has been received. The Presidential Address was delivered by Dr. A. H. Cockayne, Director General, Department of Agriculture, Wellington, and the following papers were presented ; abstracts of those marked with an asterisk will be found in the June, 1939, issue of *Herb. Abstr.* (See also *Herb. Rev.* 6. 43 and 208. 1938.)

*W. J. A. McGregor. Tussock-grassland farming in the South Island.
*C. S. Marshall. The place of permanent pasture in back-country sheep farming.
*J. M. Smith. Top-dressing of pastures in Otago and Southland.
*A. W. Hudson and J. W. Woodcock. Our present knowledge of the value of rock phosphate.
*J. E. Macassey. Research problems of the South.
*S. H. Saxby. Ryegrass strains in Otago and Southland.
*W. R. Harris. Ryegrass in Southland.
*A. H. Flay. Pasture seed-mixtures for districts of low rainfall.
*A. Stuart. Pasture seed-mixtures for districts of high rainfall.
N. R. Foy. The seed trade.
*E. O. C. Hyde. The present state of our knowledge concerning low germination in perennial ryegrass seed.
R. P. Connell and I. L. Elliott. The agricultural survey of Hawkes Bay.
I. J. Pohlen. The soil survey in Hawkes Bay.
*E. A. Madden. The pasture survey in Hawkes Bay.
N. J. Dolamore. Farm shelter in New Zealand (with special reference to Southland and Otago.)
W. C. Stafford. Irrigation in the South Island.
*M. J. Scott. Pigs in Canterbury.
*W. A. Jacques. The effect of intensity of defoliation on root development and production in some pasture-grass species.
*V. G. Cole. The stock-parasite position in relation to grassland.
*I. D. Blair. The agricultural value of *Phalaris tuberosa.*
C. V. Dayus. Evidence of iodine deficiency in domestic animals.

Alfalfa Improvement Conferences

The following is a quotation from *Chronica Botanica,* Spring 1939, of an account supplied to that journal by H. L. Westover of the Fifth and Sixth Alfalfa Improvement Conferences.

* * * * * * *

The Fifth Alfalfa Improvement Conference was held at Chicago, Illinois, December 1, 1937, the discussions being devoted largely to the progress of attempts to develop superior strains of alfalfa through selecting, selfing and crossing and through the building of synthetic strains by combining a few single plant lines which appear especially promising. In this programme which

has been carried on co-operatively between the U.S. Department of Agriculture and the various State Experiment Stations, particular emphasis has been placed on the breeding for resistance to bacterial wilt (*Phytomonas insidiosa*), a disease that has been most destructive in some of the best alfalfa districts of the United States. Due consideration has been given to types combining resistance to bacterial wilt and cold where cold resistance is essential with desirable forage qualities and good seeding habits. In some states where bacterial wilt is not a serious factor the breeding programme has been directed to the development of desirable forage types that are better adapted to certain specific soil and climatic conditions. The breeding of pasture types has also received considerable consideration, owing to the increased interest in the use of alfalfa for this purpose. At an earlier Alfalfa Improvement Conference plans were approved for testing the new lines in so-called uniform nurseries to ascertain their range of adaptation, their reaction to insects and diseases, and their value for forage and for pasture purposes as compared with the alfalfas usually grown. During 1937 a total of 44 such nurseries were located in 35 states. Seeds of approximately 80 strains were available for testing in these nurseries, but only a few nurseries received the entire number. Some states lacked the facilities for handling so many. Furthermore, lines known to be unadapted to certain conditions were not included. Notes were taken on most of the nurseries, but only where the growing season was relatively long and moisture conditions favourable was it possible to obtain yields. Detailed observational notes and yield data for 9 nurseries from which yields were obtained are in the mimeographed " 1937 Report of the Uniform Alfalfa Nurseries." While one season's results cannot be regarded as in any way conclusive, the fact that several of the new lines exceeded in yields the alfalfa usually grown offers encouragement to the progress that is being made under this programme. The Uniform nurseries represent the first step in evaluating new lines and it is expected that the response to these nurseries will serve as a guide for eliminating those lines that have no promise and for selecting a very few of the lines that are sufficiently outstanding for further testing.

A seeding technique study has been in progress at several experiment stations to determine the method of seeding, and the size and arrangement of plots that will give the most dependable data where the amount of available seed is necessarily limited. While the results are not conclusive it appears that for observational and relative yields tests, rows replicated and properly spaced may be just as reliable as larger plots. Considerable attention has also been given to factors affecting seed production. Studies conducted at the Wisconsin Agricultural Experimental Station indicate that the stigmatic membrane is the principal variable affecting seed formation under field conditions. The process of tripping ruptures the stigmatic membrane and other conditions being favourable effective pollination is thus assured. Pods may arise from untripped flowers in the field depending apparently on the environmental conditions as they affect development of the membrane. Other factors which may be of greater or lesser importance in the limitation of seed production aside from insects and disease variables are : (1) the failure of the pollen tube to reach all of the ovules ; (2) the failure of fertilization even though pollen tubes are abundantly present in the ovary ; (2) the death of the embryos at an early stage of development ; (4) a high incidence of pollen tube abortion in some plants ; and (5) an abnormal positional relationship between stigma and anthers.

Alfalfa was seriously damaged in Wisconsin in January, 1937 as a result of an ice sheet that covered a large area in the southern part of the state. Cold-resistant alfalfas such as Grimm and Hardigan demonstrated their superiority under such conditions by the higher percentage of survival. Investigations of the nature of ice sheet injury suggest that it is primarily the result of an accumulation of the by-products of respiration of which the most toxic is probably carbon dioxide.

* * * * * * *

The Sixth Alfalfa Improvement Conference held at Manhattan, Kansas, June 24 and 25, 1938, was devoted mainly to a consideration of factors related to seed production. Studies conducted at Madison Wisconsin, to find an explanation for the increased seed production from cross-pollination as compared with self-pollination showed the difference to be associated with two

phenomena. First, the alfalfa is partially self sterile, that is, male gametophytes while not impotent on the individual from which they arise are less effective in accomplishing fertilization than are unrelated male gametophytes. Second, there is a markedly greater tendency for ovules containing inbred rather than hybrid embryos to collapse during development. From investigations conducted at Lincoln, Nebraska, it was concluded that under favourable conditions fertilization takes place very rapidly and during a very limited period in the life history of each flower. In pollinating flowers with a mixture of their own pollen and pollen from another plant, the latter was found to be the effective agent 88.8 per cent of the time.

Investigations at Logan, Utah, were concerned mainly with the relation of *Lygus* bugs to seed production. These bugs by puncturing the young buds, flowers and seed pods of alfalfa do some mechanical damage but the greatest injury is believed to result from disturbed physiological functions in the plant and the faulty development and failure in the function of the reproductive structures. In other studies *Lygus* sp., of which *Lygus hesperus* constitutes 80 per cent, were shown to be responsible for serious reduction in seed yields in Arizona and California.

Conference on Desert Reclamation

The first plenary meeting of the Committee for Reclamation of Deserts, Highlands, and Riverine-lands of the U.S.S.R. was held at the U.S.S.R. Academy of Agricultural Science, Moscow, on February 10 to 15, 1938, when some thirty reports were read and then discussed in three sectional committees, namely, reclamation of deserts and semi-deserts, presided over by I. V. Larin, reclamation of river sandy-lands, presided over by A. G. Gael, and reclamation of highlands, presided over by P. A. Baranov. No official publication incorporating the reports and discussions has appeared, but some of the agrobotanical reports have been reviewed in *Sovet. Bot.* 1938. Nos. 4-5. pp. 185-8, by A. Prozorovskiĭ and L. E. Rodin, and are presented below in an abridged form.

E. P. Korovin (State Univ. Tashkent) summarized " The results and prospects of research on desert reclamation in Uzbekistan ", and demonstrated a new geobotanical map (1 : 1,000,000) of the vegetation of Uzbekistan and Kara-Kalpakia, in which, as a result of new findings, Kyzyl-Kum has been referred to the northern type of desert. The reporter described the effect of extensive grazing on the study of vegetation and also experiments on the seeding of herbage plants to improve productivity of certain areas. Seeds of many desert plants, which are distinguished by low germination, showed a conspicuous increase in germination (from 3 to 100 per cent) after scarification with sand. It was found that seeds of ephemerals did not require more than 40 to 60 per cent moisture, or high temperatures ; germination began at 7°C., the optimum being about 15°C.; seeds ceased germination and lost their vitality at temperatures above 30°C.

Amelin (Inst. of Karakul Breeding, Samarkand) reported on experiments on the cultivation of herbage plants in deserts. Wild species presented some unexpected difficulties. Perennial plants produced seeds of very low germination ; ephemerals which are particularly valued for their fodder qualities germinated fairly well, but did not respond to agronomic methods ; *Salsola* species responded to agronomic treatment, but are inferior to the ephemerals in fodder quality. Information was given on seasonal dynamics of plant chemism in relation to ecology and phenology, and also on the preparation of fodders from some indigenous plants (*Alhagi* and *Artemisia*).

I. G. Andreev (Kazakistan Inst. of Animal Breeding, Alma Alta) reported on the effect of mowing and grazing on desert plants. In *Artemisia* species, a maximum accumulation of plastic substances and forage occurred in July ; later the plants began to dry and the quantity of forage and plastic substances was reduced, although fodder quality was still superior to that of grasses. Summer mowing did not affect the forage yield in the following year, thus suggesting that *Artemisia* can be used without a summer rest, as has previously been maintained.

P. P. Begučev (Agric. Inst. Saratov) reported on his successful results on the introduction of *Kochia prostrata* into cultivation under the conditions of Kalmuck desert, where it produced some 15 to 30 dz. of forage per ha., thus considerably exceeding the yield of natural grasslands.

E. A. Maljugin (Expt. Station, Chelkar) read a paper on " Ecological conditions for the development of cultivated plants in the Aral desert " ; the research at the Station has been considerably enlarged, both in scope and in scale since 1933. Particular attention has been devoted to the importance of " trench cultivation " under irrigation.

Žerdev (Agric. and Forestry Sta., Termez, Uzbekistan) reported on experiments on the cultivation of small grain crops in the desert ; sowings were made in inter-drill furrows, with underground water at a depth of 6 to 8 m. Successful experiments were made with aerial sowings of *Elymus giganteus* and *Arthrophytum*, and with the planting of trees and shrubs in these furrows, thus providing new and reliable methods of binding sands.

P. G. Streljnikov (Expt. Sta., Karaganda) gave details of large-scale experiments with many plants and trees. Experiments with millet, wheat and lucerne showed that their cultivation is quite feasible in Central Kazakistan.

As compared with the success attained at other Stations, results of research at the Repetek Station, reported by B. N. Semevskiĭ, seemed to the Committee to be very insignificant and unconvincing ; the experiments were still confined to small plots and the plants recommended did not differ from those cultivated in the vicinity of the Station long before its foundation (cf. *Herb. Abstr.* 6. 46. 1936).

I. V. Larin (Inst. of Fodders, Kachalkino) reported on " The fodder lands of deserts and semi-deserts in U.S.S.R. and their rational utilization and improvement." The total fodder area amounts to 213 million ha., but the greatest part is characterized by low productivity and requires a great deal of work to increase and improve its fodder value ; in this connexion the reporter outlined a programme of research and agronomic measures which should be put into force immediately.

A. G. Gael (Inst. of Plant Industry, Leningrad) in his report on " The sandy lands of U.S.S.R., and their economic significance," stressed general aspects of the problem of reclamation of river sands, irrespective of their location.

G. N. Čerdancev (Acad. Sci. Moscow), referring to the reports of expeditions of the U.S.S.R. Academy of Sciences, discussed " The aspects of reclamation of Kara-Kum," and stressed the urgency for a complex research programme and for desert reclamation in general.

The problems of highland reclamation were dealt with by P. A. Baranov (for Pamir), G. V. Kovalevskiĭ (for Caucasus) and by Nuždin (for mountainous Daghestan).—M.A.O.

International Society of Phytosociology

In *Ecology*, January, 1939, it is reported that the above society is being organized with the following aims :

1. The development of phytosociology (and geobotany) by a closer collaboration between phytosociologists and ecologists.

2. The formulation of questions of phytosociological and geobotanical nomenclature destined to be presented to the International Botanical Congress and the ruling on questions of priority and validity of the systematic units of phytosociology or the terms used in geobotany.

3. The organization of excursions and scientific trips for the solution of certain scientific and economic botanical problems.

4. The creation of an international centre of phytosociology in constant relation with the international and national committees. The International Station of Geobotany at Montpellier, France, is proposed as the centre of the new society. This centre would have the following functions : (1) to make available all general or specific bibliographical references on phytosociology, or geobotany, of the definite groups of vegetation which have been published ; (2) to furnish information on the work in progress, on phytosociological mapping, on the groups of vegetation known but not yet published (tables of associations, charts of groupings, etc.) and on their geographical divisions ; (3) to permit the consultation of the superior units of vegetation (alliances, orders, classes, etc.) ; (4) to give addresses of reliable forms from which to procure apparatus of good quality for ecological measurements (5) to publish an annual report giving notices and making known the decisions of the national or international committees.

ANNOTATIONS

Great Britain (410)

A Survey of English Grasslands

A survey of grassland throughout the whole of England is being carried out by the Welsh Plant Breeding Station, Aberystwyth, Great Britain, under the general supervision of Professor Sir George Stapledon, and Mr. William Davies. The survey is being made along lines similar to those adopted in the survey of Wales made earlier (see " A survey of the agricultural and waste lands of Wales," edited by R. G. Stapledon and published by Faber and Faber, London, 1936, price 15s.).

The grasslands are divided into groups according to their botanical composition, temporary leys being distinguished from older established pastures. For the purpose of the survey the one inch to one mile $\left(\frac{1}{63360}\right)$ ordnance survey maps are used and the zonal distribution of various types of grassland is shown for the country as a whole. When these grassland zones are established typical samples are chosen within each and a more critical survey is made within the sample. For this purpose, either the six inch to the mile $\left(\frac{1}{10560}\right)$ or the 25 inch to the mile $\left(\frac{1}{2500}\right)$ ordnance survey sheets are used.

The chief objectives of the survey are, first, to determine the *status quo* of existing pastures and rough grazings for the country as a whole and then to consider methods whereby grassland improvements may be brought about in various zones and districts. The survey has already proceeded far enough to enable one to say that English grasslands are capable of far-reaching improvements At the present time permanent pastures in lowland districts are characteristically dominated by *Agrostis*, *Holcus* and *Festuca rubra*, whereas the rough grazings may consist largely of *Nardus*, *Molinia*, *Festuca ovina*, *Galluna* and *Eriophorum*. With the help of modern technique and equipment, coupled with the great use of the plough, the better grasses, such as *Lolium*, *Dactylis* and *Phleum* could be grown successfully over a much greater area of England than is at present the case.—WM.D.

National Atlas

In the *Journal of Ecology*, Vol. 27. No. 1. February, 1939, a note is published on a proposed national atlas of Britain or the British Isles. At the Cambridge meeting of the British Association in 1938, a committee was appointed under the Chairmanship of Prof. Eva G. R. Taylor, University of London, to consider the possibility and desirability of producing a National Atlas of Great Britain and Northern Ireland or, alternatively, of the British Isles. The proposed atlas would aim at a strictly objective and scientific presentation of the natural conditions, natural resources and economic utilization of the land and the adjacent sea and the history and prehistory of the country, and of the distribution, occupations, movement and social conditions of the population.

Representatives of the Council of the British Ecological Society who are also members of the Atlas Committee undertook to bring the matter before the Society with the object of securing its approval and support. The present note in the *Journal of Ecology* is intended to bring this matter to the notice of members and to invite suggestions and offers of co-operation in the preparation of suitable maps illustrating the distribution of British plants and animals, of vegetation and of other data of biological interest.—R.O.W.

Germany (43)

Limburgerhof, an Agricultural Experiment Station

An historical account of the Limburgerhof, an Agricultural Experiment Station situated near Ludwigshafen, in the Palatinate, is given in *Mitt. Land.* 54. 189-90, 208-9. 1939. The property was bought by the well-known firm I. G. Farbenindustrie in 1899. From 1914 onwards it has been in use as an Experiment Farm, and was enlarged in 1917. The land is composed of poor, permeable river sand ; the average annual rainfall is 540 mm. only, and is unfavourably distributed, with frequent drought in spring and summer. The winters, however, are not severe. Of the 150 hectares of land, 125 are arable land, five hectares meadow, and twenty-two permanent pasture. In spite of this ratio of arable to grass land, 5 : 1, and the generally poor natural conditions, stocking has been increased from some ten horses, fifty milk cows and forty-five young cattle in 1917 to seventeen horses, three bulls and 150 milk cows, and a large number of pedigree pigs and poultry at the present day. Nor does the improvement concern merely the quantity of stock carried, for in performance also (milk production, quality of the stock, etc.) first-class results are recorded. Of especial interest, however, is the fact that these results are being obtained very largely on the basis of home-grown fodder, and the use of concentrates is relatively small. Reorganization with a view to excluding concentrates has comprised the extension of the lucerne area (now 30 hectares, providing 8 kg. lucerne hay per cow per day), the improvement and rotational grazing of the existing grassland (pigs are grazed in paddocks, as well as the cattle), and a great development of catch-cropping. The original condition of the soil has become greatly improved, not only through regular manurial treatment, but also through the heavy stocking.—G.M.R.

Frame-drying of clover and grass

A film illustrating the frame-drying of clover and grass has been made by Dr. R. Geith for the Reich Ministry of Education, Berlin, 1938. It is briefly described in *Forschungsdienst.* 7. No. 4. Abstr. Sect. 183. 1939. The film, which is 180 metres in length, portrays successively the construction and technique in the use of Swedish fencing, the hurdle rack, stakes and tripods.—G.M.R.

U.S.S.R. (477)

Academy of Sciences of Ukraine

In *Visti Akad. Nauk URSR*, Nos. 1-2, pp. 129-32, 1939, a list is given of some 136 publications issued in 1938 by about twenty-four institutions operating under the auspices of the Academy of Sciences of Ukraine, Kiev. (*=Received at the Bureau).

Institute of Biochemistry

*Biohimčnyi Žurnal. Vol. 11 and 12.

A. V. Palladin. Chemical nature of vitamins (Ukrainian and Russian editions).

B. I. Goldstein. Investigation of biochemistry of proteins of tissues (in Russian).

Institute of Botany

*Žurnal Instytutu Botaniky AN. URSR. Nos. 16 (24), 17 (25), and 18/19 (26/27).
*Zbirnyk Pracj, prisvjačenyi Pam'jati Akad. O. V. Fomina.
*Zbirnyk Pracj, prisvjačenyi Pam'jati Akad. V. M. Ljubimenko.
Geobotaničnyi Zbirnyk, No. 2.
*M. G. Minaĭlova. Flora and vegetation of Ukraine Bibliography (in Ukrainian).
N. G. Cholodny. Charles Darwin and modern knowledge of insectivorous plants (in Ukrainian).
*" Flora URSR." second edition (in Ukrainian).
D. O. Svirenko. Identification of fresh-water algae. Vol. 2. (in Ukrainian).
*D. K. Zernov. Marshlands of Ukraine (in Ukrainian).

Institute of Microbiology

Mikrobiologičnyi Žurnal. Vol. 5.
M. M. Pidoplička. Indentification of fungi damaging cultivated plants (in Ukrainian).

Norway (481)

Norwegian Bog Cultivation Society

An account of the weather and crops in 1938 at the experiment station of the above Society at Mæresmyra is given in *Medd. det norsk. Myrselsk.* 37. 59-61. 1939. Seed of meadow plants was sown on May 19, of turnips, swedes and beet on May 31. Timothy was in flower on July 20. Cutting took place on July 7. On grass bog the yield on the rotation fields was as follows :—

	Rotation with 3-year ley	*Rotation with 4-year ley*	*Rotation with 5-year ley*
1st year ley	824	758	836
2nd „ „	728	696	822
3rd „ „	504	589	706
4th „ „	—	578	740
5th „ „	—	—	674
Average ..	685	655	756

On moss bog on which the soil had not been improved or limed the yield of hay was 340 kg. per dekar, with lime 540 kg., and with lime and sand 664 kg., which is to be regarded as a good yield on this soil.

Turnips, swedes and beet were taken up on October 1. The yield of roots and the percentage of dry matter of some of the varieties were as follows :—

Dales hybrid (Norwegian)	6833 kg.	roots	with	8.9	per cent	dry	matter
Fynsk bortfelder	8028 „	„	„	8.1	„	„	„
White early turnip	7083 „	„	„	11.5	„	„	„
Østersundom	8500 „	„	„	8.5	„	„	„
Barres fodder beet	2445 „	„	„	12.3	„	„	„
Eckendorfer fodder beet	3056 „	„	„	11.4	„	„	„
Fodder sugar beet	2222 „	„	„	14.2	„	„	„

R.P.J.

Netherlands (492)

Ensilage in the Netherlands

Attention is drawn, in a report by C. K. van Daalen, Bilthoven, 1939, to the steady increase in the practice of ensilage in practically every province of the Netherlands, as indicated by the amount of A.I.V. and German acid imported (principally the former). This has increased since 1934 by more than 50 per cent annually, and at the same time the acid now supplied is of a much greater strength than that obtained in 1934.—G.M.R.

Artificial drying of grass

The first Report of the Committee for the Artificial Drying of Grass is published by the Netherlands Central Bureau for Animal Nutrition (Frankena, H. J. Het kunstmatig drogen van gras. Groningen [1939.] pp. 44.) The results of trials of the Kaloroil drier, made in 1938 at Burum, Leeuwarden and Stolwijk, respectively, are presented and discussed, with special reference to costs.

U.S.A. (748)

Unguarded Seed Importation

The following note by H. P. Barss, Washington, D.C., on the *Danger in unguarded seed importation* appears in the Phytopathological notes in *Phytopathology*, Vol. 28. No. 12. Dec., 1938.

" World agriculture seems as yet hardly to comprehend the extent to which the seeds of plants serve as potential carriers of destructive plant pathogens prevalent in different regions of the earth. In spite of Orton's excellent bulletin on seed-borne parasites and other efforts to place before the public the growing evidence of the seed-dissemination of a wide range of plant diseases, there still appears to be very little public recognition of the fact that unguarded transportation of seeds from one continent to another is fraught with the danger of introducing previously absent disease-producing agents or biotypes into new regions. Moreover, there seems to be but slight general appreciation of the fact that the long and intensive work by plant breeders to build up superior varieties of crop plants resistant to the major diseases prevalent in their respective countries is constantly threatened with failure as long as there is danger of the seed-introduction of new parasites to which such superior varieties may be susceptible.

" The importance of these considerations is emphasized by such announcements as that in July, 1938, of a new anthracnose (*Colletotrichum* sp.) of cotton found in Manchukuo. No one knows the possible damage that might result were this introduced into America, but when it is considered that the ordinary cotton anthracnose (*C. gossypii*), seed-carried, was the predominant cause of destructive seedling blight in 9 important cotton states in 1938, it at once becomes evident that a new cotton anthracnose accidently introduced in seed might well have serious consequences like those confronting American mint growers from the spread of mint anthracnose, or American potato growers from the spread of the destructive bacterial tuber ring rot and wilt both of which perhaps have been introduced unwittingly in propagating stock from some other continent. It is a matter of satisfaction that a sub-committee of The American Phytopathological Society, headed by M. T. Munn of the New York Experiment Station, Geneva, is giving serious consideration to the problem of dealing more effectively with seed-borne plant diseases. This committee deserves active support in its constructive endeavours."

Mr. P. V. Cardon

Mr. P. V. Cardon, who has been acting as one of the Corresponding Editors for this Bureau in U.S.A. for the past few years, has now been appointed Assistant Chief, Bureau of Plant Industry, U.S. Department of Agriculture. His place as corresponding editor for the Division of Forage Crops and Diseases, U.S. Department of Agriculture is now taken for the meantime by Acting Principal Agronomist in Charge, Mr. H. L. Westover.

Brazil (81)

Pasture renovation at the Pindamonhangaba Experiment Station

In an article published by J. C. Salgado in *Rev. Industr. anim.* N.s. 2. No. 1. 62-8. 1939, it is noted that the Station has abandoned the practice of renovating pastures by mowing. Experience has proved it not merely to be expensive, but to give ephemeral results only, for weeds—especially if mown in the period August to February—sprout with increased vigour within a few days, and ant-hills, when burnt and then destroyed with a spade, reappear in an average percentage of fifty. The following new process has been adopted. Ant-hills (numbering approximately thirty per alqueire) are destroyed and any necessary clearing is done, the pastures are ploughed and harrowed, dressed with bone meal (800 kg. per alqueire), again harrowed, and sown with maize (38 kg. per alqueire). The maize is thinned out and then earthed up, and, in the furrows left between the rows of maize by the latter process, grasses are sown or (more frequently) grass shoots are planted, without disturbing the earth about the maize. The grasses are sown or planted in pure cultures, in areas the size of which varies in direct ratio to the palatability to cattle of the species concerned, and in inverse ratio to its invasive capacity. The species chosen have different growth periods. There is thus ensured a supply of herbage for all seasons of the year, and an avoidance of monotony. The following is the planting scheme adopted by the Station, the first area being that at the highest altitude, the rest following in order of descent. *Melinis minutiflora*, 1 alq. ; *Panicum maximum*, 2 alq. ; *Hyparrhenia rufa*, 1 alq. ; *Panicum maximum* var. *gongylodes*, 2 alq. ; *Pennisetum purpureum*, 1 alq. ; *Chloris gayana*, 1 alq. ; *Paspalum notatum*, 2 alq. ; *Brachiaria plantaginea*, 2 alq.; *Pennisetum clandestinum*, 2 alq. ; *Panicum barbinode* Trin., 2 alq.

A detailed account of the costs of each process, including the harvesting, carrying and threshing of the maize, shows that there is a substantial balance in hand after the maize has been sold and the improvement completed.

The urgent need for improved pastures, especially where valuable, foreign breeds of cattle have been introduced, is stressed.—G.M.R.

Argentina (82)

Forage Experiment Station in Patagonia

The Ministry of Agriculture, Argentina, is engaged in studying the forage problem of the province of Patagonia, in which connexion an extensive programme of research has been mapped out. This includes the creation of an experiment station for forage problems, which has been founded in the far-distant locality of Cañadón León, Santa Cruz, Patagonia, situated at latitude 48° 40′ S. and longitude 70° west of Greenwich. The climate is characterized by low rainfall (150 to 200 mm. annually) and by very low temperature during the winter season (as low as -25°C.), and the region by stony soil covered with sparse xerophytic vegetation, subject to frequent and extremely violent winds. The experiments comprise the acclimatization of as wide a collection as possible of grasses and forage legumes (without excluding any other botanical family)

for cultivation under both dry conditions and irrigation. For this last project there is an ample supply of water obtained from the Rio Chico, which forms one of the boundaries of the 2,000 hectares that constitute the new Experiment Station for Forage Problems.

In connexion with these activities the Director of Agriculture would appreciate as complete as possible a collection of seeds of forage plants obtained from regions which, in regard to their geographical situation and climatic and soil conditions, are similar to those indicated in the south of the territory of Santa Cruz. Seed samples should be addressed to :—

Director de Agricultura,
Ministerio de Agricultura de la Nacion,
Dirección de Agricultura,
Buenos Aires,
Argentina.

SEED EXCHANGE

Seeds for trial in Patagonia

The Director of Agriculture, Argentina, wishes to receive samples of seeds which may be suitable for growing under the severe conditions experienced on the location of the experiment station now being formed in Patagonia. Details of these conditions are described on page 145. Correspondents of the Bureau working under similar conditions are requested to collaborate as far as possible in supplying seeds for these experiments. Seeds of forage grasses, legumes or plants of any other botanical family which may be considered of forage value under these conditions would be welcomed.

Royal Botanic Gardens, Kew

The following is a list of seeds of herbage plants which have ripened at Kew during 1938.

Agropyron spp.
Agrostis spp.
Anthyllis montana var. *atrorubens*
— *Vulneraria*
Arrhenatherum elatius
Astragalus spp.
Atriplex spp.

Brachypodium distachyum
— *sylvaticum*
Briza maxima
Bromus spp.

Dactylis glomerata

Echinochloa Crus-galli
Eragrostis chloromelas
— *maxima*

Festuca Myuros

Glyceria plicata
Glycyrrhiza lepidota

Hydysarum coronarium var.
— *esculentum* [*album*
— *flavescens*
Helianthus spp.
Holcus mollis

Lotus spp.
Lupinus spp.

Medicago spp.
Melica spp.
Melilotus albus
— *officinalis*

Ornithopus compressus
— *sativus*
Oryzopsis miliacea
— *paradoxa*

Panicum capillare
Panicum miliaceum
Phalaris canariensis
— *minor*
Phaseolus spp.
Phleum pratense
Pisum spp.
Poa spp.

Setaria glauca
— *italica*
Stipa Calamagrostis

Trifolium spp.
Trigonella spp.
Triticum ovatum

Vicia spp.

Royal Botanic Garden, Edinburgh

The following is a list of herbage plants in the Royal Botanic Garden, Edinburgh, from which ripened seeds have been collected during the year 1938.

Anthyllis spp.
Arrhenatherum elatius
Artemisia spp.
Astragalus spp.
Avena bromoides
— *sempervirens*

Brachypodium ramosum
Briza maxima

Dactylis glomerata
Desmodium tiliaefolium

Elymus arenarius

Festuca spp.

Lotus corniculatus
— *Tetragonolobus*
Lupinus spp.

Medicago Echinus
Melica nutans
Melilotus alba

Onobrychis viciaefolia

Oryzopsis miliacea

Pennisetum longistylum
Phleum pratense
Poa caespitosa

Stipa capillata
— *pennata*

Trigonella maritima

Vicia spp.

Seed Varieties in the Netherlands

SEEDS LIST

The *Fifteenth Descriptive List of Varieties*, published by the Plant Breeding Institute, Wageningen, 1939 (p. 232), provides detailed information on the varieties of seed available in the Netherlands, their source, principal characters, and quality, and the associations or firms from which they may be obtained. An indication of quality is given by letters, as follows : **A**—recommended ; **B**—recommended for trial ; **N**—new, or insufficiently known ; **L**—old local varieties ; **O**—no longer described, of small importance ; **D**—dropped and no longer accepted for field inspection. Information concerning the firms or breeders from whom varieties are available, and more detailed information as to the characteristics of the grasses, may be had on application to the Bureau.

Grasses

Lolium perenne.

Permanent pasture types.

L. 783. From best old indigenous pasture.

L. 784. Indigenous, collected in the Netherlands.

N. 958. C.B. pasture type.

Sown pasture types.

B. 697. Neerlandia I.

B. 785. E.F. 79, Danish.

N. 962. C.B. hay type.

Lolium italicum.

B. 786. Roskilde, Danish.

B. 500. Neerlandia I.

N. 507. Oldenburg ryegrass. (Intermediate between *Lolium perenne* and *L. italicum*.)

Lolium italicum var. *Westerwoldicum.*

A. 305. Neerlandia I., selected.

L. 816. Indigenous.

Festuca pratensis.

B. 802. Neerlandia I.

N. 803. Otofte, Danish.

L. 801. Indigenous, collected in the Netherlands.

Festuca arundinacea.

N. 306. Neerlandia I.

Festuca rubra.

N. 959. Neerlandia II. For lawns, sports grounds, etc.

Festuca ovina, vars. *tenuifolia* and *duriuscula.*

Phleum pratense.

B. 604. Neerlandia I., for permanent grassland.

B. 501. Svalöf Gloria. Hay type.

Poa trivialis.

Poa pratensis.

N. 503. Beemster. Pasture type.

N. 960. Neerlandia II. Pasture type.

Poa fertilis.

N. 789. German strain.

Poa nemoralis.

Dactylis glomerata.

L. 798. Indigenous, collected in the Netherlands.

N. 799. Neerlandia I.

N. 800. Lochow's selection, German.

Alopecurus pratensis.

Cynosurus cristatus.

L. 795. Indigenous, collected from premanent pasture.

Agrostis tenuis, A. stolonifera and *A. canina.*

L. 961. Netherlands mixed bent, mostly collected from wild stands.

Arrhenatherum (*Avena*) *elatius.*

N. 793. Polish strain, from Cracow.

Trisetum (*Avena*) *flavescens.* Seed obtained mostly from France ; some is grown in Germany.

Clovers

Trifolium pratense.

L. 41. Roosendaal indigenous.

L. 42. Limburg Maas clover.

L. 440. Brabant red Maas clover.

L. 676. Groningen red clover.

N. 677. Bohemian, early flowering.

L. 992. Hungarian variety, with seal of origin.

L. 999. Zevenburg indigenous.

N. 763. Escofar (Essex County Farmers), English.

L. 1003. Suffolk red clover.

L. 1000. East Anglian.

N. 767. Tystofte 40, Danish.

N. 1001. Tystofte I, early, Danish.

N. 900. Smaragd (emerald), Swedish.

N. 903. Essi, Swedish.
N. 898. Hjelm, Danish.
N. 766. Otofte, Danish.
N. 768. Pajbjerg, Danish.
N. 902. Lindby, Swedish.
N. 899. Femo, Danish.
N. 901. Göta, Swedish.
N. 977. Karaby, Swedish.
N. 1002. Tystofte I, Danish, late.

Trifolium repens.
L. 978. Escofar wild white, English.
L. 914. Kentish wild white, English.
L. 104. Indigenous, cultivated, seed grown in Friesland and Groningen.
N. 904. Otofte Morsö, Danish.
L. 916. Morsö, guaranteed, Danish.
N. 765. Pajbjerg Grassmark, Danish.
N. 842. Escofar, English.
L. 917. Hungarian.
L. 918. Bohemian.
L. 919. Polish.

Trifolium hybridum.
L. 920. Swedish.
L. 921. Canadian.
L. 922. Bohemian.
L. 979. Polish.
L. 980. Baltic.

Medicago lupulina.
N. 842. Escofar, English.
L. 981. English.
L. 982. Scottish.
L. 983. Danish.
L. 984. Luxemburg.

Trifolium incarnatum.
N. 907. Hooster, selected from Limburg local variety.
N. 985. Escofar, English.
L. 986. Hungarian.

Melilotus alba, French.

Medicago.
L. 987. Hungarian, seal of origin.
L. 988. Bohemian.
L. 989. Slovakian.
L. 990. Czechoslovakian.
L. 991. Provence.

Ornithopus sativus.
L. 923. Indigenous.
L. 993. Polish.

Hedysarum coronarium. (Imported.)

Vicia villosa.
L. 924. Indigenous.
L. 994. Hungarian.
L. 995. Baltic.

Vicia sativa.
A. 91. "Negro vetch." Selected from Gelders vetch, 1922 and 1926. Leafy, productive, black seed.
L. 996. Indigenous guaranteed.
Seed is imported also from the Baltic States and the Balkans.

Lupinus.
N. 760. Alkaloid-free sweet lupin, *L. luteus*, German.
N. 843. Alkaloid-free blue sweet lupin, *L. angustifolius*, German.
L. 997. *L. luteus*, bitter, indigenous.
L. 998. *L. luteus*, bitter, Polish.
Lupinus angustifolius, bitter, also imported.

Glycine hispida.
N. 905. Platt soybean.

Three legume varieties (red clover, blue lupin, and crimson clover) and a millet are listed as having been dropped.—G.M.R.

Calcutta

Readers may be interested in extracts from a letter sent by Dr. W. Burns, Agricultural Commissioner with the Government of India, giving a list of the members of the Gramineae in the Herbarium material from Kashmir contained in the Botanical Garden Herbarium at Calcutta, as well as the list of Himalayan high-altitude fodder grasses.

Himalayan high-altitude fodder grasses.

1.	*Panicum miliaceum* L.	up to 11,000 ft.
2.	*Setaria viridis* Beauv.	
3.	*Penniseum flaccidum* Criseb.	12,000 ft.
4.	*Hierochloe laxa* R. Br.	15,000 ft.
5.	*Alopecurus pratensis* L.	12,000 ft.
6.	*Milium effusum* L.	12,000 ft.
7.	*Phleum alpinum* L.	15,000 ft.
8.	*Phleum pratense* L.	
9.	*Agrostis alba* L.	13,000 ft.
10.	*Trisetum subspicatum* Beauv.	12,000 ft.—17,000 ft.
11.	*Avena pratensis* L.	
12.	*A. pubescens* L.	
13.	*Danthonia kashmiriana* Jauh.	11,000 ft.
14.	*Koeleria cristata* Pers.	12,000 ft.
15.	*Dactylis glomerata* L.	8,000 ft.
16.	*Briza media* L.	13,000 ft.
17.	*Poa pratensis* L.	11,000 ft.—12.000 ft.
18.	*P. trivialis* L.	11,000 ft.—12,000 ft.
19.	*Graphephorum mutans* Munro.	15,000 ft.
20.	*Festuca ovina* L.	15,000 ft.
21.	*Festuca elatior* L.	
22.	*Bromus asper* Murray.	12,000 ft.

Herbarium material of species of Gramineae from Kashmir in the Botanical Garden Herbarium, Calcutta.

1. *Panicum sanguinale* Linn.=*Digitaria sanguinalis* Scop. var. *commutata.*
2. *Panicum Isachne* Rott.
3. *Pennisetum lanatum* Klotz.
4. *Fragus racemosus* Scop.
5. *Saccharum spontaneum* Linn.
6. *Erianthus versicolor* Nees.
7. *Arthraxon lanceolatus* Hack.
8. *Andropogon Ischaemum* Linn.
9. *Andropogon sorghum* Brot. var. *halepensis* =*Sorghum vulgare.*
10. *Anthistiria anathera* Nees.
11. *Apluda varia* Hack.
12. *Phalaris arundinacea* Linn.
13. *Hierochloe laxa* Br.
14. *Alopecurus laguriformis* Schur.=*A. brachystachyus* Bieb.
15. *Aristida cyanatha* Steud.
16. *Stipa pennata* Linn.
17. *S. capillata* Linn.
18. *S. sibirica* Lamk.
19. *S. Jacquemontii* Jaub. and sp.
20. *Agrostis alba* Linn.
21. *Calamagrostis emodensis* Griseb.
22. *C. littorea* D.C.
23. *Avena pratensis* Linn.
24. *Duthiea bromoides* Hack.
25. *Phragmites communis* Trin.
26. *Melica Jacquemontii* Don.=*M. Cupani* Guss.
27. *Poa bulbosa* Linn.
28. *P. alpina* Linn.
29. *P. attenuata* Trin. = *P. sterilis* Bieb.
30. *Poa pratensis* Linn. var. *angustifolia.*
31. *Elymus dasystachys* Trin.
32. *Festuca ovina* Linn.
33. *Bromus inermis* Leyss.
34. *B. inermis* Leyss. var. *villosus*
35. *B. oxydon Schrenk.* = *B. macrostachys* Desf.
36. *Agropyron longearistatum* Boiss.
37. *Triticum Aegilops* Beauv.
38. *Catabrosa mutans* Stapf.

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